20

ARGENTINE BEEF RISK ASSESSMENT

Richard Fite, Robert McDowell
Craig Chioino, Adam Grow
Animal and Plant Health Inspection Service
United States Department of Agriculture

INTRODUCTION

The purpose of this document is to assess the probability that beef exported from Argentina as allowed by APHIS's Final Rule, CFR 94.21, would be contaminated with foot-and-mouth disease (FMD) virus.

This document answers the question, "What is the probability that fresh, chilled, or frozen beef imported from Argentina according to the requirements specified in the Final Rule and other existing USDA regulations regarding imported beef will be contaminated with FMD?" The analysis assumes that beef exported in full compliance with CFR 94.21 will have a negligible risk of contamination with FMD virus. The document evaluates the probability that fresh, chilled, or frozen beef exported in response to the Final Rule but not in full compliance with certain requirements of the Rule will be contaminated with FMD.

The assessment begins by identifying three "un-planned" risk pathways linking an initiating activity --cattle slaughtered for export-- to an adverse outcome --the export of FMD contaminated beef. These pathways are identified and are shown diagrammatically in a scenario tree (Figure 1). The pathways are: 1) Beef which was not maturated to pH 5.8 and not diverted to domestic Argentine use; 2) Beef from which lymph nodes, bones, and/or blood clots were not completely removed; and 3) Beef from which lymph nodes, bones, and/or blood clots were not completely removed and which was not maturated to pH 5.8 and not diverted for domestic use in Argentina. Beef exported in full compliance with CFR 94.21 follows the "as-planned" pathways in the scenario tree.

Other unplanned pathways are possible and with some creativity and imagination, perhaps several dozen unplanned pathways could be identified. Time and resource limitations do not permit the evaluation of every conceivable unplanned risk pathway. The three unplanned pathways evaluated in this assessment were selected because in the authors' opinion, they represent the most probable sources of disease risk.

The next step in the assessment requires assigning quantitative probability values to each branch point in the pathways. As much as was possible, values were assigned based on factual evidence and the evidence is listed and referenced. Ideally, values should be based on the results of specific, focused, replicated research results and surveillance data. However, such results and data are rarely, if ever, available for risk assessment, and the use of

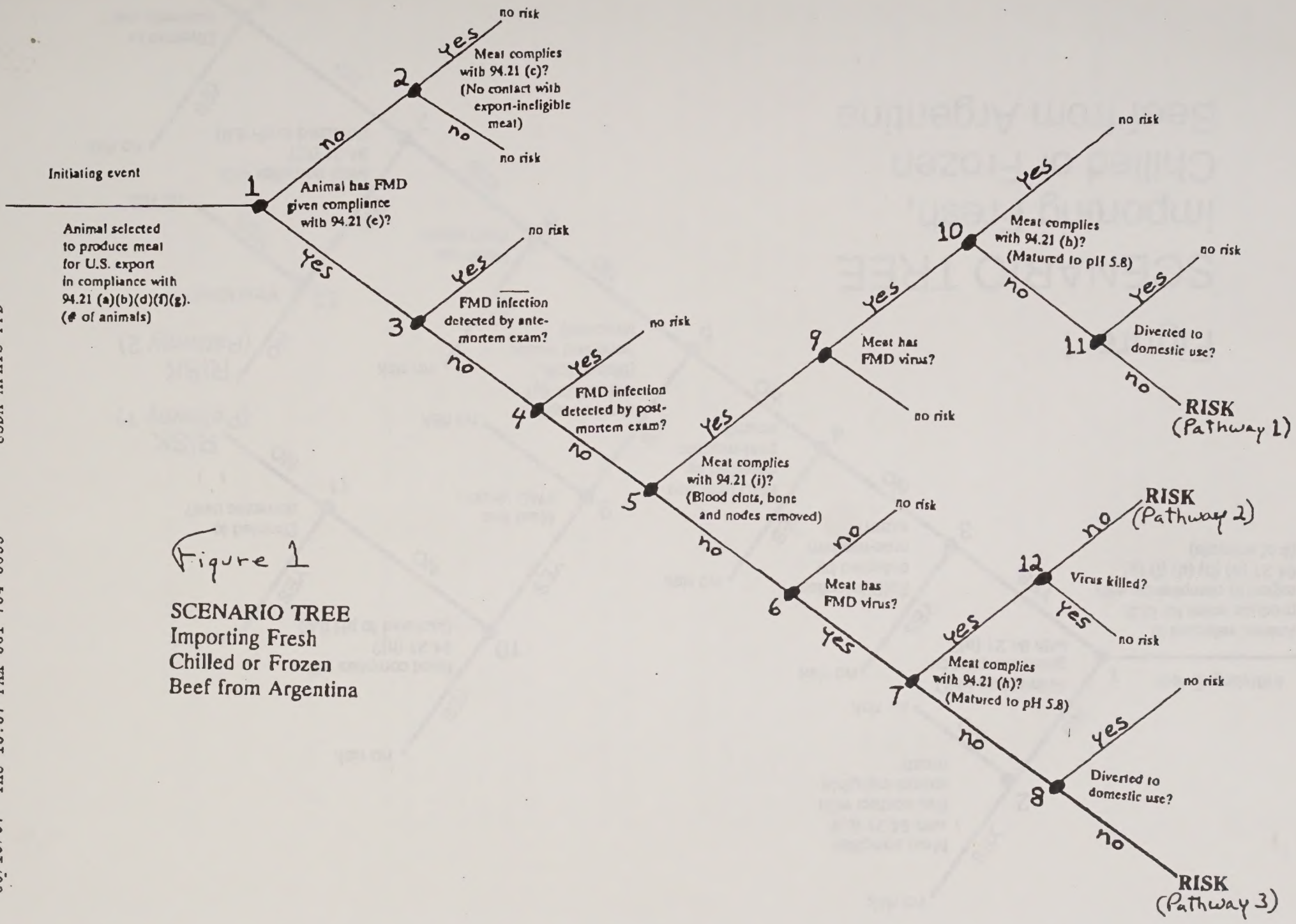


Figure 1

SCENARIO TREE
Importing Fresh
Chilled or Frozen
Beef from Argentina

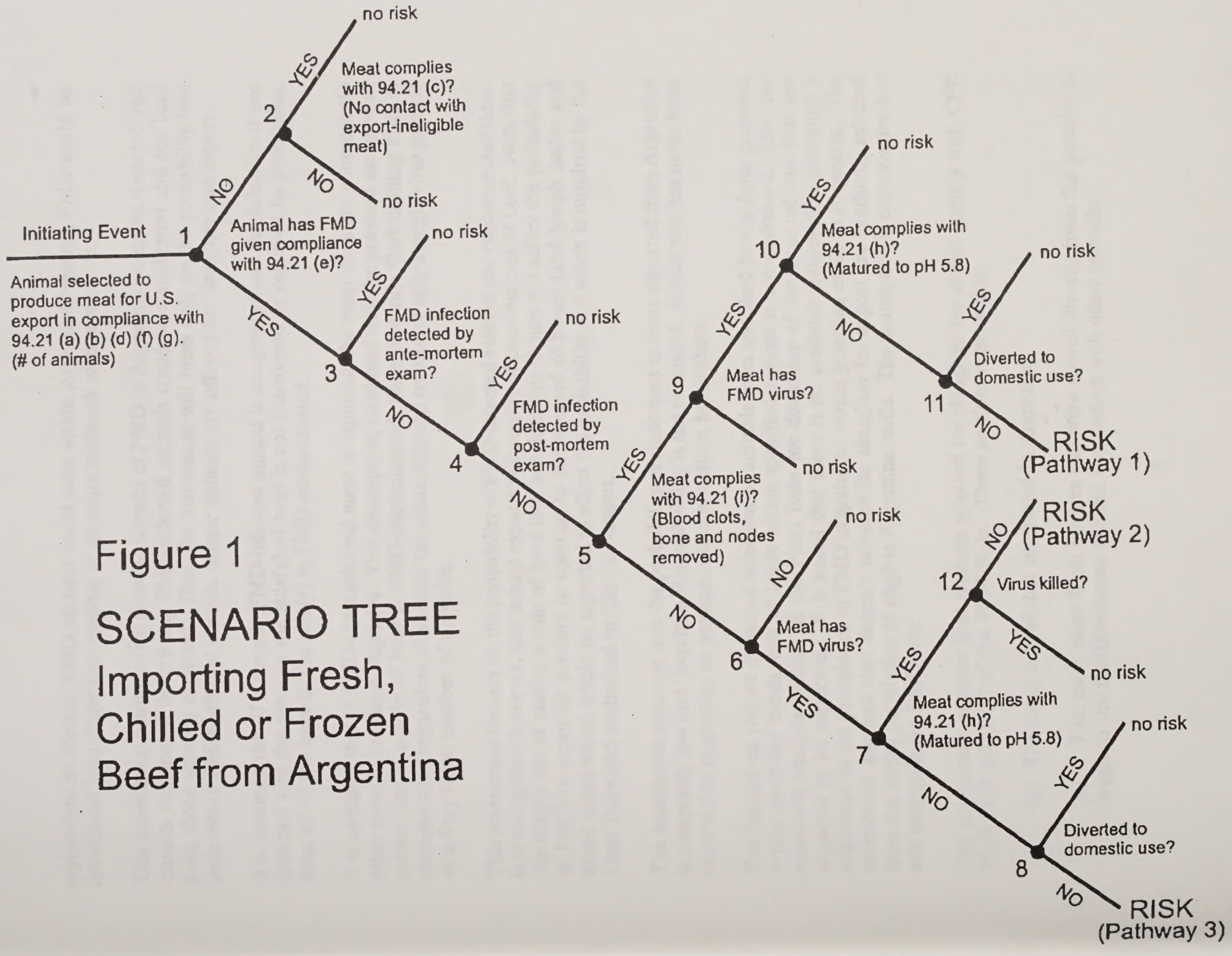


Figure 1

SCENARIO TREE

Importing Fresh, Chilled or Frozen Beef from Argentina

asymptomatic chronic FMD carriers could exist within Argentina; second, FMD could be introduced into Argentina leading to an acute outbreak of disease.

This assessment assumes that acute outbreaks of FMD in Argentina would be detected and exports terminated before any FMD-infected animals could be slaughtered and the beef from those animals exported. Thus, the assessment will focus only on the probability that undetected FMD-infected chronic carrier animals are offered for slaughter and export.

It is assumed that if a chronic FMD-infected animal is slaughtered and the infection is not detected and the virus in the side(s) of beef is not inactivated or removed by processing, then all of the beef in the side(s) is FMD contaminated.

It is assumed that if FMD-contaminated meat is exported, the meat does not contaminate other meat in the same shipment. This assumption, combined with the previous assumption means that if a side of beef is FMD-contaminated, the entire side (but nothing else) is contaminated regardless of whether the contamination consists of only a single virus particle or a very large number of particles.

This assessment focuses on the probability of FMD-infected animals and contaminated sides. It is recognized however, that actual exports will consist of boneless cuts of beef. Note that the simple act of *cutting* a side of beef into boneless cuts should not affect the probability of FMD in exported product in contrast to the *removal* of bones (and lymph nodes and blood clots) which would be expected to affect the probability and which is required by the Final Rule and addressed in this assessment.

The assessment assumes that the probability of rinderpest in meat exported from Argentina is acceptably low and therefore this probability is not evaluated. Rinderpest has never been reported in Argentina or anywhere in the western hemisphere.

The impact on risk of clustered selection of animals from specified herds, from grass-fed versus grain-fed herds, and of herds within specified regions is not addressed. (See the economic analysis section of the Final Rule for discussion of the types of cuts that are expected to be exported.) It is noted that there is no available information indicating a difference in the prevalence of FMD in grain-fed versus grass-fed cattle in Argentina. The assessment assumes that animals selected for slaughter for export are randomly selected from the entire population of eligible Argentine cattle. The assumption is conservative and will overestimate FMD risk.

The assessment assumes that animals selected for slaughter for export comply with CFR 94.21 (a)(b)(d)(f)(g) of the Final Rule. These sections require that:

(a) The meat is beef that originated in Argentina

(b) The meat came from bovines that were moved directly from the premise of origin to the slaughterhouse without any contact with other animals;

these chronic FMD carriers could not [illegible] [illegible] would [illegible] Argentina [illegible] [illegible] [illegible].

[illegible] assumes the [illegible] [illegible] [illegible] [illegible] [illegible] s terminate [illegible] any FMD [illegible] could be [illegible] [illegible] those animals exported. [illegible] [illegible] [illegible] the probability and [illegible] FMD-infected chronic carrier [illegible] [illegible] [illegible].

assumed that if a chronic FMD [illegible] [illegible] [illegible] the [illegible] [illegible] and the virus [illegible] [illegible] [illegible] be beef in (or sides) as FMD [illegible].

[illegible] if FMD-contaminated meat is [illegible] [illegible] [illegible] [illegible] of beef is FMD [illegible] [illegible] [illegible] regardless of whether the contamination consists of [illegible] [illegible] the number of [illegible].

[illegible] [illegible] FMD [illegible] [illegible] [illegible] [illegible], however, that actual exposure [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] which would be expected [illegible] the probability [illegible] [illegible] addressed in this [illegible].

[illegible] that the probability [illegible] [illegible] therefore [illegible] is not [illegible] [illegible] [illegible] the western [illegible].

[illegible] on risk of [illegible] [illegible] [illegible] [illegible] [illegible] within specific regions [illegible] analysis section [illegible] [illegible] that there is no [illegible] [illegible] of FMD in [illegible] [illegible] that animals [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

[illegible] [illegible] [illegible]

subjective, expert judgement is necessary. This is as true for this risk assessment as it is for every risk assessment.

Finally, a mathematical model was developed based on the scenario tree. Using this model and the quantitative values for each branch point, the probability that imported beef would be contaminated was calculated. The results are expressed as the probability that any given side of beef would be contaminated and as the probability of importing one or more contaminated sides of beef per year.

Uncertainty in branch point values is unavoidable. The assessment uses probability distribution functions to address uncertainty. @Risk software (Palisade Corporation) was used to multiply distributions.

All probability values in this risk assessment are conditional on the branch points in the pathways preceding a given branch point. Thus, for example, the probability of detecting a FMD-infected animal during post-mortem exam of the carcass (branch point 4) is conditional on the animal complying with 84.21 (a)(b)(d)(f)(g), having FMD, and not being detected by ante-mortem exam (branch points 1 and 3).

Risk assessments are only as good as the quality of information used to perform them. Risk assessment is a dynamic process, i.e., the results can change as better, more complete information is obtained. Readers with specific factual information relevant to the branch point values in this assessment are encouraged to make such information available to APHIS.

The prevalence of FMD in South America will probably decrease with time as a consequence of the Pan American Health Organization's FMD eradication activities. Thus, the probability that exported meat from any South American country, Argentina included, would introduce FMD to the United States should similarly decrease. U.S acceptance of South American origin beef provides an important incentive for South American countries to pursue FMD eradication. The resulting decreased probability of the introduction of the disease into the U.S. should be recognized as a significant benefit.

ASSUMPTIONS

By agreement between Argentina and the United States, imports of beef are limited to 20,000 metric tons per year. It is assumed that 20,000 metric tons per year will be imported. Depending on number of kilograms of beef exported per animal slaughtered, the number of cattle required to produce 20,000 metric tons can be calculated. If the amount of beef exported is greater or less than the 20,000 metric tons expected, the probability of FMD should change porportionally.

[illegible] measurement [illegible] very [illegible]

A mathematical [illegible] during this [illegible] the probability that [illegible] ced. The results [illegible] ide of [illegible] r, one or [illegible] cont [illegible]

[illegible] ty [illegible] fragility [illegible] ccessive [illegible] twice (Pr. 2.60) [illegible]

[illegible] Sa, [illegible] ling [illegible] atrn 1 [illegible] and 3).

Measurements are only [illegible] than. [illegible] point val [illegible] assessment [illegible]

[illegible] col [illegible] on [illegible] with [illegible] S [illegible] South [illegible] and [illegible] o the U. [illegible]

and the United [illegible] tas [illegible] rates [illegible] [illegible] rate of [illegible]

The International Organization for Epizootics (OIE) has recognized Argentina as being free of FMD with vaccination. This assessment assumes that Argentina's reports to OIE about FMD and the OIE's classification of Argentina are accurate and reflect the best information available concerning the prevalence of FMD in Argentina. Thus, there are only two ways in which an FMD-infected animal could be slaughtered and offered for export. First, undetected, asymptomatic chronic FMD carriers could exist within Argentina; second, FMD could be introduced into Argentina leading to an acute outbreak of disease.

This assessment assumes that acute outbreaks of FMD in Argentina would be detected (and exports terminated) before any FMD-infected animals could be slaughtered and the beef from those animals exported. Thus, the assessment will focus only on the probability that undetected FMD-infected chronic carrier animals are offered for slaughter and export.

It is assumed that if a chronic FMD-infected animal is slaughtered and the infection is not detected and the virus in the side(s) of beef is not inactivated or removed by processing, then all of the beef in the side(s) is FMD contaminated.

It is assumed that if FMD-contaminated meat is exported, the meat does not contaminate other meat in the same shipment. This assumption, combined with the previous assumption means that if a side of beef is FMD-contaminated, the entire side (but nothing else) is contaminated regardless of whether the contamination consists of only a single virus particle or a very large number of particles.

This assessment focuses on the probability of FMD-infected animals and contaminated sides. It is recognized however, that actual exports will consist of boneless cuts of beef. Note that the simple act of *cutting* a side of beef into boneless cuts should not affect the probability of FMD in exported product in contrast to the *removal* of bones (and lymph nodes and blood clots) which would be expected to affect the probability and which is required by the Final Rule and addressed in this assessment.

The assessment assumes that the probability of rinderpest in meat exported from Argentina is acceptably low and therefore this probability is not evaluated. Rinderpest has never been reported in Argentina or anywhere in the western hemisphere.

The impact on risk of clustered selection of animals from specified herds, from grass-fed versus grain-fed herds, and of herds within specified regions is not addressed. The assessment assumes that animals selected for slaughter for export are randomly selected from the entire population of eligible Argentine cattle. It is noted that this assumption differs slightly from APHIS's Regulatory Impact Analysis which discusses grass-fed beef. Because no information is available indicating a different FMD prevalence in grain-fed versus grass-fed beef, analysis of risk from either

[illegible] Organization for Epizootics (OIE) [illegible] being free of FMD without [illegible]. This assessment [illegible] Argentina's requests to USDA about [illegible] of Argentina [illegible] available concerning the presence of FMD [illegible], there are only two ways in which an FMD-infected [illegible] could be [illegible] and [illegible] export [illegible] domestic [illegible]; second, FMD could be introduced into Argentina [illegible] other [illegible] disease.

[illegible] assumes that [illegible] and [illegible] could be [illegible] detected and the beef from [illegible]. Thus, the assessment will focus only on the probability [illegible] FMD-infected [illegible] and export.

[illegible] assumes that if a second [illegible] FMD-infected animal is [illegible] infection is not detected and the virus [illegible] not inactivated or [illegible] by processing. Thus all of the [illegible] the side(s) is FMD contamination.

[illegible] is assumed that if FMD-contaminated meat is exported, [illegible] contaminate other meat in the same shipment. [illegible] assumption, combined with the previous assumption that [illegible] of beef is FMD-contaminated, [illegible] contaminated regardless of [illegible] consist of only a single virus particle or a very large [illegible].

[illegible] focuses on the probability of FMD-infected [illegible] contaminated sides. [illegible], however, [illegible] will consist of boneless [illegible] beef. [illegible] of cutting a side of beef into boneless cuts should [illegible] probability of FMD [illegible] in contrast [illegible] of bone and [illegible] to affect the probability [illegible] addressed in this [illegible].

[illegible] that the [illegible] imported [illegible] worldwide.

[illegible] or risk of clus[illegible] grass-fed versus grain-fed [illegible] regions is not [illegible]. For example [illegible] of [illegible] rarely [illegible] Argentina's [illegible]

grain-fed or grass-fed beef is not possible. Assuming random selection of animals from the entire national herd will overestimate FMD risk in comparison to analyses that allow for clustered selection of animals, either within specified herds, or from grass-fed or grain-fed herds, or within specified regions.

The assessment assumes that animals selected for slaughter for export comply with CFR 94.21 (a)(b)(d)(f)(g) of the Final Rule. These sections require that:

(a) The meat is beef that originated in Argentina

(b) The meat came from bovines that were moved directly from the premise of origin to the slaughterhouse without any contact with other animals;

(d) The meat came from bovines that originated from premises where foot-and-mouth disease and rinderpest have not been present during the lifetime of any bovines slaughtered for export of meat;

(f) The meat came from bovines that originated from premises on which ruminants or swine have not been vaccinated with modified or attenuated live viruses for foot-and-mouth disease at any time during the life of the bovines slaughtered for export of meat; and

(g) The meat came from bovines that have not been vaccinated for rinderpest at any time during the lifetime of any of the bovines slaughtered for export of meat.

Evidence justifying this assumption includes: 1) The use of modified live or attenuated FMD vaccine is illegal in Argentina; 2) The use of rinderpest vaccine is illegal in Argentina; 3) Rinderpest is a highly contagious disease which has never been reported in Argentina or anywhere in the western hemisphere; and 4) Argentina has been declared FMD free with vaccination by the OIE for FMD.

It is assumed that beef that is maturated to pH 5.8 and that does not contain lymph nodes, bones, and blood clots has negligible risk. Abundant research literature exists demonstrating that FMD virus does not survive in muscle tissue at pH 5.8 (Cottral et al, 1960).

Other assumptions pertaining to only a single branch point in the scenario tree will be addressed as part of the evidence for that branch point.

[illegible] ... or grain fed cattle, or with [illegible]

[illegible] with [illegible] (1)(b) or (1)(g) of [illegible] shall require that:

The meat is not [illegible] originated in [illegible]

(e) The meat came from [illegible] or [illegible] and slaughtered [illegible] official [illegible]

(f) [illegible]

(g) The meat came from bovines that [illegible]

The meat came from bovines [illegible]

[illegible] this meat [illegible] or [illegible]

[illegible] that beef must be [illegible] bovines [illegible]

[illegible] be [illegible]

EVIDENCE

Initiating Event

The initiating event is the selection of animals for slaughter to produce beef for export to the United States. The initiating event is quantified as the number of animals per year selected.

IE-1 Beef cattle weigh approximately 350-450 kg or about 800-1000 pounds. After skinning, evisceration, and removal of the head and feet, a beef carcass weighs approximately 225 kg (495 lbs). (pers. comm., M. Garcia, APHIS-NCIE staff, 1997)

IE-2 U.S. ground beef supplies are adequate and prices low. Therefore, Argentine beef exports are expected to consist of primarily better cuts of meat. Such cuts constitute a relatively small fraction of a beef carcass. (pers. comm., M. Malik, APHIS-NCIE staff, 1997)

IE-3 APHIS's site visit team proposed in its Back-to-Office Report that 10 kg of beef per slaughtered animal be assumed for risk assessment purposes. (Metcalf and Blackwell, Back-to-Office Report, 1994).

IE-4 Two million cattle are required to produce 20,000 metric tons of beef if only 10 kg of beef is exported per animal slaughtered. (APHIS staff calculation)

IE-5 Some APHIS staff believe that the quantity of beef exported per animal slaughtered will be substantially more than 10 kg. The quantity exported per slaughtered animal is likely to increase with time as Argentine beef becomes more accepted in U.S. markets. (pers. comm., R. McDowell, APHIS-PPD staff, 1997)

IE-6 APHIS staff have no confidence that the quantity of meat exported per animal slaughtered would exceed 100 kg or 10 times the estimate in the Metcalf/Blackburn report. 200,000 cattle are required to produce 20,000 metric tons of meat if 100 kg of beef is exported per animal slaughtered. 400,000 cattle are required to produce 20,000 metric tons of meat if 50 kg of beef is exported per animal slaughtered. (APHIS staff estimate)

Branch Point 1

Branch point 1 is the probability that an animal going to slaughter has FMD, given that it is an Argentine-origin animal. This probability is designated f1.

1-1 Argentina has a cattle population of approximately 50 million animals. Close to 100% of these animals are eligible for slaughter for export. (Situation of the FMD Control Programs in South America, Pan American Health Organization, 1996)

[illegible] Consumption of [illegible] in the United States. [illegible] 100 of the [illegible] of cattle [illegible] per year [illegible].

Beef cattle will be approximately 25-48 [illegible] or about 200-[illegible]. After skinning, [illegible] and removal of [illegible] a beef carcass [illegible] [illegible]
[illegible], H. Garcia, APHIS [illegible], 1990)

U.S. ground beef [illegible] are [illegible] [illegible]. Argentine beef exports [illegible] exported [illegible]
cuts of meat [illegible]
of a beef carcass [illegible] [illegible] comm., [illegible]
[illegible])

[illegible]'s [illegible] 10 kg of beef [illegible]
[illegible] purposes. [illegible]

million cattle are [illegible] 21,00[illegible]
[illegible] of beef is [illegible]
[illegible] (APHIS staff calculation)

Some APHIS staff believe that the [illegible]
per animal slaughtered [illegible]
[illegible] by experts [illegible]
[illegible] time [illegible] Argentine [illegible] accepted in U.S.
[illegible] comm. [illegible], 1990)

[illegible] staff have no [illegible]
per animal slaughtered would [illegible]
in the [illegible]. [illegible] report [illegible] 20[illegible]
to produce 20,000 metric tons of meat [illegible]
[illegible] animal slaughtered. [illegible],000 cattle are [illegible]
10,000 metric tons of meat [illegible] of beef is [illegible]
slaughtered. (APHIS staff [illegible])

[illegible] the probability that an animal going to slaughter [illegible]
given that it is an Argentine origin animal. [illegible]
[illegible] defined [illegible].

[illegible] a cattle [illegible] of approximately [illegible]
[illegible] animals are eligible for
[illegible] FMD control [illegible]

1-2 The last reported outbreaks of FMD in Argentina occurred in April, 1994. Fifteen premises were affected with FMD type O and 2 premises with type C. (PAHO, 1996)

1-3 90% of cattle in Argentina are vaccinated with an inactivated FMD vaccine. Sheep, goats, and pigs in Argentina are not vaccinated for FMD and therefore serve as sentinel animals. (PAHO, 1996)

1-4 100% of the cattle in Argentina are under a national FMD surveillance program. (PAHO, 1996)

1-5 Argentina has been recognized by the OIE as free of FMD with vaccination. (OIE Meeting, Paris, 1997)

1-6 Given that Argentina has not had any reported outbreaks of FMD in over three years, that Argentina has a large population of susceptible pigs, sheep, goats, that 10% of the Argentine cattle population is not vaccinated, and that Argentina has effective national surveillance for FMD, it is assumed that the most likely number of chronic FMD carriers in Argentina is zero and the maximum possible number of chronic FMD carriers is 10. (APHIS staff estimate)

1-7 Given evidence 1-1 and 1-6, the maximum probability that a randomly selected animal in Argentina has undetected FMD is 10 divided by 50 million = 2 x 10E-7. (APHIS staff calculation)

Branch Point 2

Branch point 2 is the probability that the meat complies with 94.21 (c). 94.21 (c) requires that the meat has not come in contact with meat from countries other than those listed in CFR 94.1 (a) (2). This probability is designated f2.

It is theoretically possible that meat not in compliance with 94.1 (a) (2) could contaminate meat exported from Argentina. However, time and resources being limited, APHIS staff determined that this is a less important risk pathway and therefore assumed a probability of 1 for the yes pathway at branch point 2.

Branch Point 3

Branch point 3 is the probability that FMD infection will be detected before or during the ante-mortem exam, given that the slaughtered animal is FMD infected. This probability is designated f3.

FMD-infected chronic carriers typically display no clinical symptoms and no grossly visible pathology. Therefore, the assessment assumes that ante-mortem examination will not detect FMD-infected chronic carriers and specifies a probability of zero for detection. Because it is possible, however unlikely, that

[illegible] of cattle [illegible]
[illegible] the [illegible] with [illegible]
[illegible] 1989 [illegible]
[illegible] surveillance [illegible] animals.

[illegible] in [illegible]
(PAHO, 1 [illegible])

" [illegible] has been [illegible] by the [illegible]
. (OIE May [illegible])

[illegible] has [illegible]
[illegible] less [illegible]
[illegible] of the Americas [illegible]
[illegible] that [illegible]
[illegible] i.e. [illegible]
[illegible] in Argentina [illegible] the maximum
of chronic [illegible]

[illegible] evidence 1 [illegible] and 1-6, the maximum probability that
selected animal in Argentina [illegible]
by 30 million = 2 x 10 [illegible]

[illegible] is the probability that [illegible]
(b) requires that the meat [illegible]
[illegible] other than those listed in CFR [illegible]
[illegible] designated [illegible]

[illegible] that [illegible]
[illegible] be [illegible]
[illegible] BMII [illegible]
[illegible]
[illegible] point 2.

[illegible]
[illegible]
[illegible] probability [illegible]

[illegible]
[illegible] will not [illegible]
[illegible] probability of [illegible]
[illegible] however unlikely, [illegible]

ante-mortem exam might detect FMD infection, the assumption overestimates risk.

Branch Point 4

Branch point 4 is the probability that FMD would be detected during post-mortem exam of a slaughtered animal, given that the animal has FMD and the infection was not detected during ante-mortem exam. This probability is designated f4.

For the same reason as at branch point 3, the assessment assumes that post-mortem examination will not detect FMD-infected chronic carriers and specifies a probability of zero for detection. The assumption, again, overestimates risk.

Branch Point 5

Branch point 5 is the probability that all blood clots, lymph nodes, and bones are removed in compliance with CFR 94.21 (i). This probability is designated f5.

5-1 The head (including pharyngeal lymph nodes), feet, and skin are normally removed from all slaughtered animals. (pers. comm., M. Malik, APHIS-NCIE staff, 1997)

5-2 Residual bone, lymph nodes, and blood clots in exported product would be unacceptable to U.S. purchasers of Argentine beef. Thus, the exporter would not only be in violation of CFR 94.21 but would also likely lose markets in the U.S. Thus it is in the Argentine's self-interest to assure compliance with 94.21 (i). (pers. comm., M. Garcia, APHIS-NCIE staff, 1997)

5-3 Beef that does not comply with 94.21 (i) can be easily detected by simple observation. (pers. comm., M. Garcia, APHIS-NCIE staff, 1997)

Branch Point 6

Branch point 6 is the probability that beef that has not had all bones, lymph nodes, and blood clots removed contains virus, given that the animal from which the beef is produced has FMD and that the infection was not detected by ante-mortem and post-mortem exam. This probability is designated f6.

6-1 It is probable that the parts of a bovine carcass that are most likely to contain virus (i.e., head, feet, and skin) are removed even if not all bones, nodes, and blood clots are removed. (Pers. comm., M. Garcia, APHIS-NCIE staff, 1997).

Because it is not possible to know precisely the parts of a carcass that are required by 94.21 (i) to be removed but have not been removed, a probability of 1 is assumed. This overestimates the actual risk.

[illegible] wed exam [illegible]
nd [illegible] was [illegible] determ [illegible]
probabili[illegible] is design[illegible]

[illegible] source of [illegible]
[illegible] often [illegible]
[illegible] specifies a probability [illegible]
[illegible] again, [illegible]

[illegible] is the probability [illegible]
[illegible]
obability is designated [illegible]

The head blacklist [illegible]
[illegible] lly removed from [illegible]
N. [illegible], IPRIS-NCSE [illegible] 1997)

[illegible]
[illegible] is unacceptable [illegible]
reporter would not only be in violation [illegible]
[illegible] ely lose market in the U.S. [illegible]
self-interest [illegible] compliance [illegible]
Garcia, IPRIS-NCSE [illegible] 1997)

[illegible] that does not display [illegible]
sample observations. [illegible] N. [illegible] 1997)

[illegible]
blood [illegible]
which the head is produced [illegible]
detect [illegible]

[illegible] of a truth [illegible]
[illegible]
[illegible] blind [illegible]
1997).

the [illegible]
[illegible] have [illegible]
overestimates the [illegible]

Branch Point 7

Branch point 7 is the probability that the meat is maturated to pH 5.8 in compliance with CFR 94.21 (h). This probability is designated f7

7-1 Meat is tested with a pH meter to determine compliance with 94.21 (h). Meat not in compliance after 36 hours may be retested after 60 hours. (CFR 94.21 (h); pers. comm., John Blackwell, 1997)

7-2 "When a muscle is in full rigor, the pH may range from 5.4 to 6.0. After 48 hours storage at temperatures slightly above the freezing point, the pH averages 5.6 to 5.9." (Cottral, Cox, and Baldwin, 1960)

7-3 Maturation is a normal component of beef slaughter and processing in Argentina. It is not done merely to satisfy USDA regulations. (pers. comm., M. Garcia, APHIS-NCIE staff, 1997)

7-4 Routine, periodic inspection by USDA personnel of slaughter plants producing beef for export would include review of beef maturation procedures. (pers. comm., M. Malik, APHIS-NCIE staff, 1997)

Branch Point 8

Branch point 8 is the probability that beef that is not matured to pH 5.8 in compliance with CFR 94.21 (h) is diverted to domestic use in Argentina. This probability is designated f8

8-1 Carcasses that do not reach the required pH are normally diverted for domestic Argentine use. (pers. comm., M. Malik, APHIS-NCIE staff, 1997)

Branch Point 9

Branch point 9 is the probability that the beef contains FMD virus, given that all bones, blood clots, and lymph nodes have been removed and that the animal was FMD infected and the infection was not detected by ante-mortem or post-mortem exam. This probability is designated f9.

9-1 Ante-mortem and post-mortem exam is likely to detect cattle with acute FMD. (Analysis of BSE Risk Factors in Argentina, http://www.mecon.ar/Agricultura/azseg2.htm, 1997)

9-2 Chronic FMD carrier animals are not likely to be viremic. The most likely anatomic site for FMD virus in chronic carrier animals is the pharyngeal lymph nodes. (Blood and Radostits, 1989)

9-3 Animals slaughtered in compliance with CFR 94.21 (h) will have had pharyngeal lymph nodes removed. (pers. comm., M. Garcia and M. Marolo, APHIS-NCIE staff, 1997)

Branch Point 10

Branch point 10 is the probability that the meat is maturated to pH 5.8 in compliance with CFR 94.21 (h). This probability is designated f10.

10-1 Meat is tested with a pH meter to determine compliance with 94.21 (h). Meat not in compliance after 36 hours may be retested after 60 hours. (CFR 94.21 (h); pers. comm., John Blackwell, 1997)

10-2 "When a muscle is in full rigor, the pH may range from 5.4 to 6.0. After 48 hours storage at temperatures slightly above the freezing point, the pH averages 5.6 to 5.9." (Cottral, Cox, and Baldwin, 1960)

10-3 Maturation is a normal component of beef slaughter and processing in Argentina. It is not done merely to satisfy USDA regulations. (pers. comm., M. Garcia and M. Marolo, APHIS-NCIE staff, 1997)

10-4 Routine, periodic inspection by USDA personnel of slaughter plants producing beef for export would include review of beef maturation procedures. (pers. comm., M. Malik and M. Garcia, APHIS-NCIE staff, 1997)

Branch Point 11

Branch point 11 is the probability that beef that is not matured to pH 5.8 in compliance with CFR 94.21 (h) is diverted to domestic use in Argentina. This probability is designated f11.

11-1 Carcasses that do not reach the required pH are normally diverted for domestic Argentine use. (pers. comm., M. Malik, APHIS-NCIE staff, 1997)

10-4 Routine, periodic inspection by USDA personnel of slaughter plants producing beef for export would include review of beef maturation procedures. (pers. comm., M. Malik and M. Garcia, APHIS-NCIE staff, 1997)

Branch Point 11

Branch point 11 is the probability that beef that is not matured to pH 5.8 in compliance with CFR 94.21 (a) is diverted to domestic use in Argentina. This probability is designated f11.

11-1 Carcasses that do not reach the required pH are normally diverted for domestic Argentine use. (pers. comm., M. Malik, APHIS-NCIE staff, 1997)

Branch Point 12

Branch point 12 is the probability that FMD virus is killed, given that the meat is matured to pH 5.8 and that not all bones, nodes, and clots have been removed. This probability is designated f12.

12-1 Bones, lymph nodes, and blood clots do not normally produce lactic acid post-mortem and therefore the pH of these tissues does not decrease as rapidly as it does in muscle tissues. (Cottral et al, 1960)

12-2 Although not all bones, lymph nodes, and blood clots are removed from the meat, it is likely that most bones, lymph nodes, and blood clots are removed. (APHIS staff estimate)

INPUT VARIABLES

Minimum, most likely, and maximum estimates for the initiating event and probabilities f1-12 are shown in Table 1.

INTRODUCTION OF FMD FROM IMPORTATION OF BEEF FROM ARGENTINA (Chronic Only)
VALUE OF INPUT VARIABLES

Estimates Of Input Variables		Minimum	MostLikely	Maximum
Initiating event - Number of animals slaughtered per year		200,000	400,000	2,000,000
f1	Animal has FMD given compliance with 94.21 (e)	0.00E+00	0.00E+00	2.00E-07
f2	Meat complies with 94.21 ( )	1	1	1
f3	FMD Infection detected by ante-mortem exam	0	0	0
f4	FMD Infection detected by post-mortem exam	0	0	0
f5	Meat complies with 94.21 ( )	0.98	0.99	0.999
f6	Meat has FMD virus	1	1	1
f7	Meat complies with 94.21(h) - matured to pH 5.8	0.8	0.9	0.99
f8	Diverted to domestic use	0.95	0.99	0.999
f9	Meat has FMD virus	0.05	0.1	0.15
f10	Meat complies with 94.21(h) - matured to pH 5.8	0.8	0.9	0.99
f11	Diverted to domestic use	0.95	0.99	0.999
f12	Virus killed	0.05	0.1	0.2

MATHEMATICAL MODEL

The probability that a side of beef from a given slaughtered animal has FMD, is not detected by ante-mortem or post-mortem exam, has all bones, nodes, and blood clots removed, has virus, is not matured to pH 5.8 and is not diverted to domestic use is:

$$f1*(1-f3)*(1-f4)*f5*f9*(1-f10)*(1-f11)*2. \qquad \text{Eqn. 1}$$

The probability that a side of beef from a given slaughtered animal has FMD, is not detected by ante-mortem or post-mortem exam, does not have all bones, nodes, and blood clots removed, has virus, is matured to 5.8, and does not have all virus inactivated by maturation is:

$$f1*(1-f3)*(1-f4)*(1-f5)*f6*f7*(1-f12)*2. \qquad \text{Eqn. 2}$$

The probability that a side of beef from a given slaughtered animal has FMD, is not detected by ante-mortem or post-mortem exam, does not have all bones, nodes, and blood clots removed, is not matured to pH 5.8, and is not diverted to domestic use is:

$$f1*(1-f3)*(1-f4)*(1-f5)*f6*(1-f7)*(1-f8)*2. \qquad \text{Eqn. 3}$$

Note that all of the above equations include a multiplier of two due to the fact that every slaughtered animal produces two sides of beef.

The probability formulas in equations 1-3 calculate the probability that a side of beef from a randomly selected bovine in Argentina would be exported contaminated with FMD virus via the specific pathways identified.

The pathways are mutually exclusive, i.e., any given side of beef exported with FMD virus could only come from one of the three pathways. Examination of the conditions pertaining to each pathway, i.e., bones and nodes removed or not removed, matured to pH 5.8 or not matured, etc. will demonstrate this. Thus, the probability that a given side of beef will contain FMD virus is the probability that it comes from either pathway 1 or pathway 2 or pathway 3, i.e., the sum of the three pathways:

$$\text{Pr (side of beef exported with FMD virus)} = \text{Pr (pathway 1)} + \text{(pathway 2)} + \text{(pathway 3)} \qquad \text{Eqn. 4}$$

Equation 4 represents the probability that a side from a randomly selected bovine in Argentina could eventually be exported with FMD virus. The number or frequency of FMD-contaminated sides exported per year is a function of the number of animals slaughtered for export to the U.S.

Many such phenomena are modelled as binomial processes, or ones where there are many "trials", each with the same probability of "success" (which, in this case, means the export of a FMD-

[illegible] not [illegible] by [illegible]
[illegible]
[illegible] 0.9 and is not [illegible]

[illegible](1-P4)*P5*[illegible]

[illegible]ility that a side of [illegible] is [illegible]
[illegible] detected by [illegible]
[illegible], nodes, and blood clots [illegible]
[illegible] does not [illegible]

[illegible]

[illegible] side of [illegible]
[illegible] is not det[illegible] by [illegible]
small bones, nodes, and blood clots [illegible]
[illegible] and is not diverted to [illegible]

[illegible]

all of the above equations include multiplication [illegible]
[illegible] that event [illegible]

formulas in equations 1-3 describe the probability
[illegible] from a randomly [illegible]
contaminated with [illegible]
[illegible].

[illegible]
[illegible]
[illegible]
[illegible]
etc. will [illegible]
[illegible] side of [illegible]
[illegible]

[illegible] changes:

[illegible]

[illegible]
[illegible]
[illegible] of animals [illegible]

[illegible]
[illegible]
[illegible]

contaminated side). A simple example of such a process is the repeated tossing of a coin; the probability of success on a given trial or toss is *p* (equal to 1/2) and the number of trials is termed *n*.

Similarly, the export of FMD-contaminated sides of beef from Argentina can be modelled as a binomial process where:

n = number of sides exported
= number of animals slaughtered * 2;

p = probability that any given side is exported with FMD virus (from equation 4); and

x = number of FMD-contaminated sides exported in one year.

The binomial model allows computation of the probability of exporting a given number of FMD-contaminated sides per year:

$$Pr(x=0) = (1-p)^n$$

$$Pr(x=1) = np(1-p)^{n-1}$$

$$Pr(x>=1) = 1 - Pr(x=0)$$
$$= 1 - (1-p)^n$$

The average, i.e., mean, number of FMD-contaminated sides exported per year is the probability that a given side is contaminated multiplied by the number of sides exported:

$$Mean\ x = n*p$$

In cases where the mean value of x is less than one, the reciprocal or inverse of np indicates the average frequency with which a FMD-contaminated side is exported. Thus, if n*p = .01 contaminated sides per year, then:

$$1/n*p = \text{years per contaminated side} = 100$$

This result, as well as being intuitive, is verified by its equivalence to the mean of the negative binomial distribution modelled for the number of "failures" (i.e., sides of FMD-free beef) expected before one "success". The following section will demonstrate this for Argentine beef.

Uncertainty in the probability values was addressed by using minimum possible, most likely, and maximum possible values for each probability and for the number of animals selected for export. Calculations were performed using Monte Carlo simulations and @Risk software.

RESULTS

Probability that Individual Side of Beef Has Live FMD Virus

The probabilities for randomly selected sides of beef being exported with live FMD virus from pathways 1,2, and 3 are represented by the probability curves in Figure 2. The spread of each curve indicates the range of uncertainty for each parameter value and the height of the curves indicates our confidence in a particular value on the x-axis. Each distribution has about the same dispersion, about 5 orders of magnitude between the minimum and maximum values (see Table 6 for summary statistics for selected model outputs). The expected values (mean or average value) for the probability that a randomly selected side of beef would be exported with live FMD virus are quite small: 7.1×10^{-12} for pathway 1; 3.5×10^{-10} for pathway 2; and 6.9×10^{-13} for pathway 2. The sum of these distributions is a distribution with mean of 3.5×10^{-10}, essentially identical to that for pathway 2 (Figure 3). Pathways 1 and 3 contribute negligibly to the sum of the three probabilities. The probability distribution shown in Figure 2 will be noted as p* in the following section.

Annual Probability of Exporting FMD-Contaminated Sides of Beef

Treating the annual export of sides of beef as a binomial process with

n = number sides exported annually
= Number of animals (Intiating Event) * 2
p = probability a side will have live FMD = p^*

allows the calculation of the probability of one or more FMD-contaminated sides being exported in one year:

$$1 - (1-p^*)^n$$

where p^* and n are random variables as described. This quantity is also a random variable or distribution and is shown in Figures 4a and 4b. The x-axes in both figures utilize log scales to better display the distribution; the nominal values that correspond to these log values are simply 10 exponentiated to the appropriate value. For example, where the log scale reads -3, the nominal value is 10^{-3} or 0.001. The mean or average for the distribution is $10^{-3.2727}$ or 5.4×10^{-4} or 0.00054. This indicates the frequency infected sides exported per year: 0.00054 infected side per year. Obviously, a side is either infected or not infected so we will convert this measure to a more meaningful indicator, the average number of years required to export one infected side.

Using the inverse or reciprocal of this rate (0.00054 sides/year), the number of years per export of 1 infected side can be calculated:

year/0.00054 = 1,862 years per exported infected side.

Thus on average we would expect to have 1,862 years of FMD-free exports before we obtain an FMD-positive export. This distribution for this variable is shown as an inverse cumulative distribution (Figure 5a) and as a typical probability curve (Figure 5b). The expected value for the distribution is $10^{3.2725}$ years (1,873 years) so the expected frequency of FMD-contaminated sides of beef is one in 1,873 years. The 5% and 95% fractiles on the inverse cumulative (or exceedence) distribution are 331 and 20,417 years, respectively. This means there is only a 5% chance the value my be less than 331 years per FMD export and a 5% chance that it may be greater than 20,417 years per FMD export.

The validity of this approximation is demonstrated by utilizing the negative binomial distribution. The negative binomial computes the probability of having *x* failures before getting *s* successes in total where the probability of success on a given trial is *p*. If "success" is defined as the export of 1 or more FMD-contaminated side in one year, then "failure" is the export of zero FMD-contaminated sides in one year. The mean of the negative binomial distribution is

$$\frac{s(1-p)}{p}$$

so substituting the appropriate values for

p = pr(exporting FMD-contaminated side per yr)
s = 1 (the number of successes or FMD exports)

yields the average number of years to get 1 FMD-contaminated side:

$$\frac{1(1-0.0053372)}{0.00053372} = 1,872 \text{ years.}$$

Thus the exact figure from the negative binomial differs, in relative terms, from the approximation using the inverse expected value by less than 1% (10/1862 = 0.005).

[illegible] of experience of this [illegible]
[illegible] per report of [illegible]

[illegible] = 1,867 years [illegible]

we would expect to have [illegible]
we obtain an [illegible]
is shown in [illegible]
as a typical probability [illegible]
for the distribution in [illegible]
frequency of [illegible]
The [illegible]
distribution [illegible]
is means there is only [illegible]
is per 1.5 report [illegible]
17 years per [illegible] report

of this approximation is [illegible]
a binomial distribution. [illegible]
of having [illegible]
the probability of success [illegible]
defined as [illegible]
year, then [illegible] the expected [illegible]
[illegible] is one year. [illegible]

[illegible]

By the approximate value [illegible]

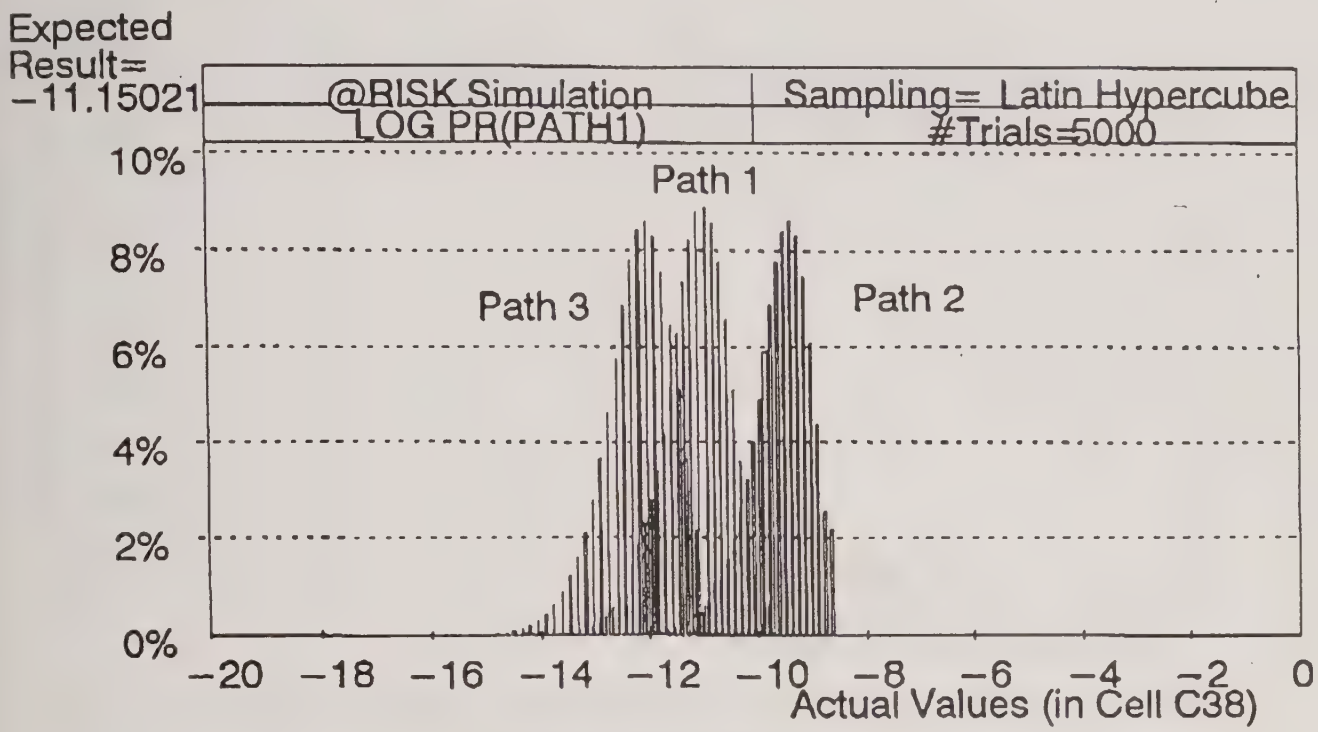
expecting [illegible]
the number of successes [illegible]

number of years [illegible]

= 1,872 years.

[illegible] Hinman [illegible]
[illegible]

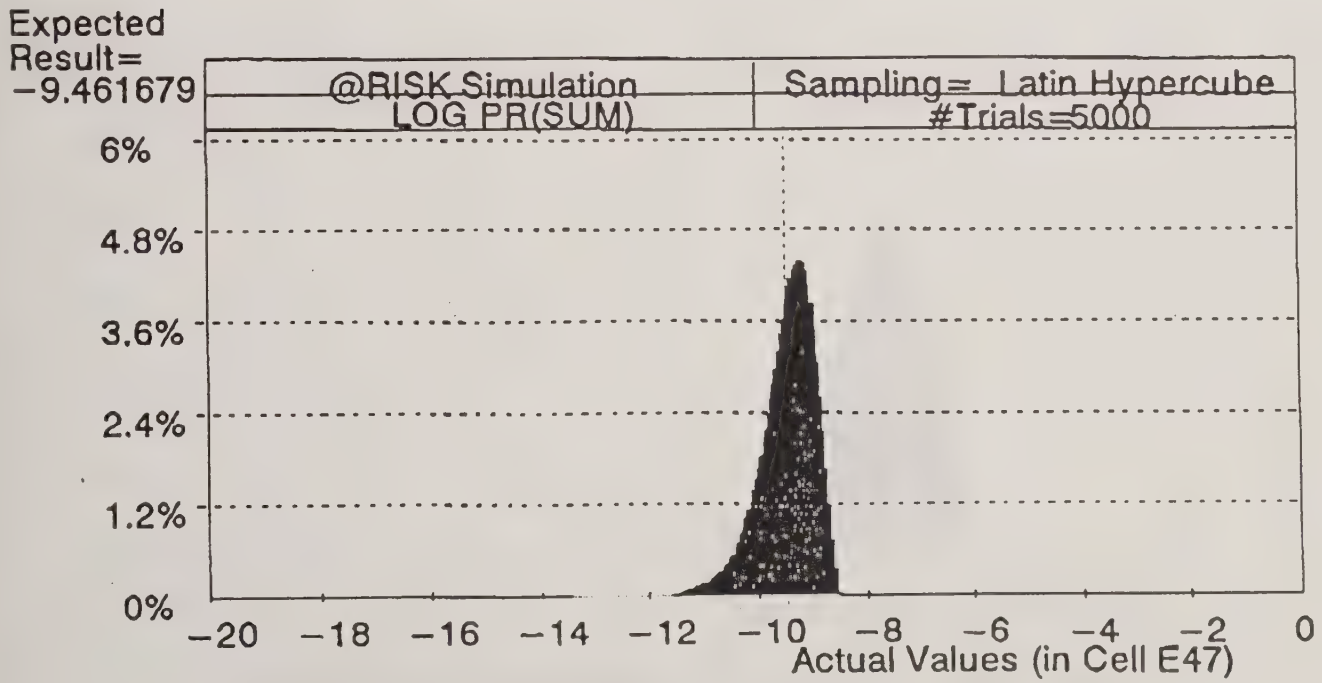
Probability of side of FMD–contaminated beef exported through various pathways.



Pat

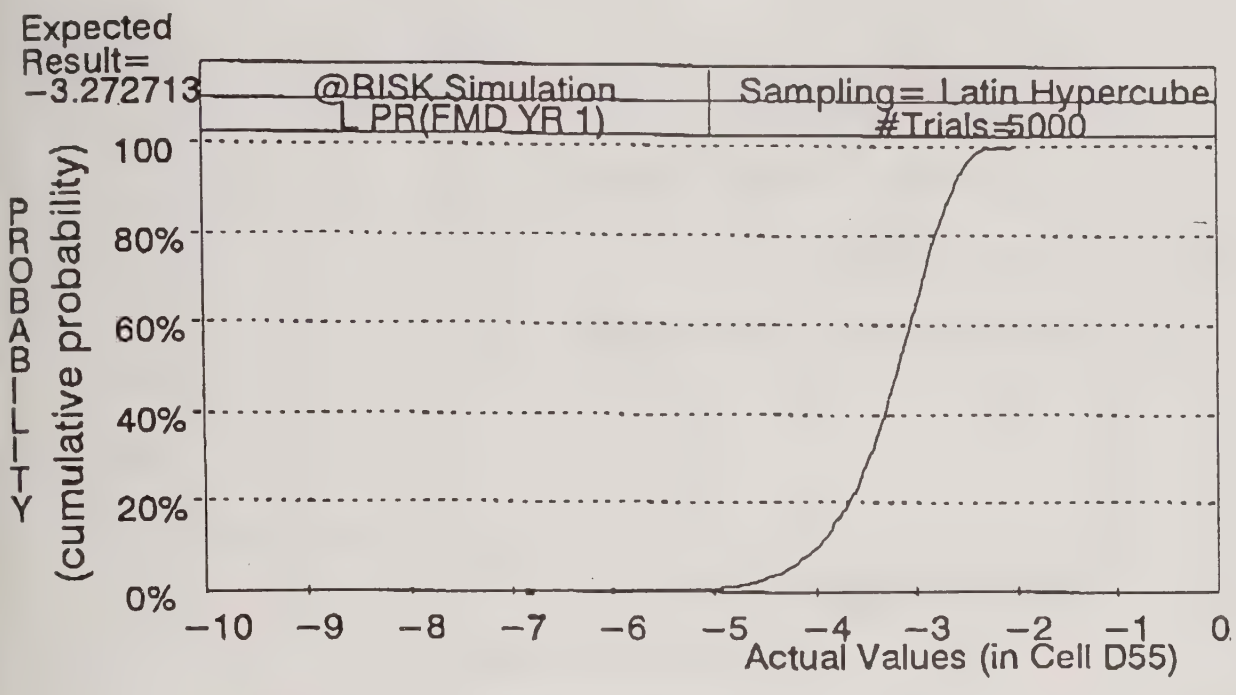
Log of Probability

Sum of probability of side of FMD–contaminated beef exported through various pathways.



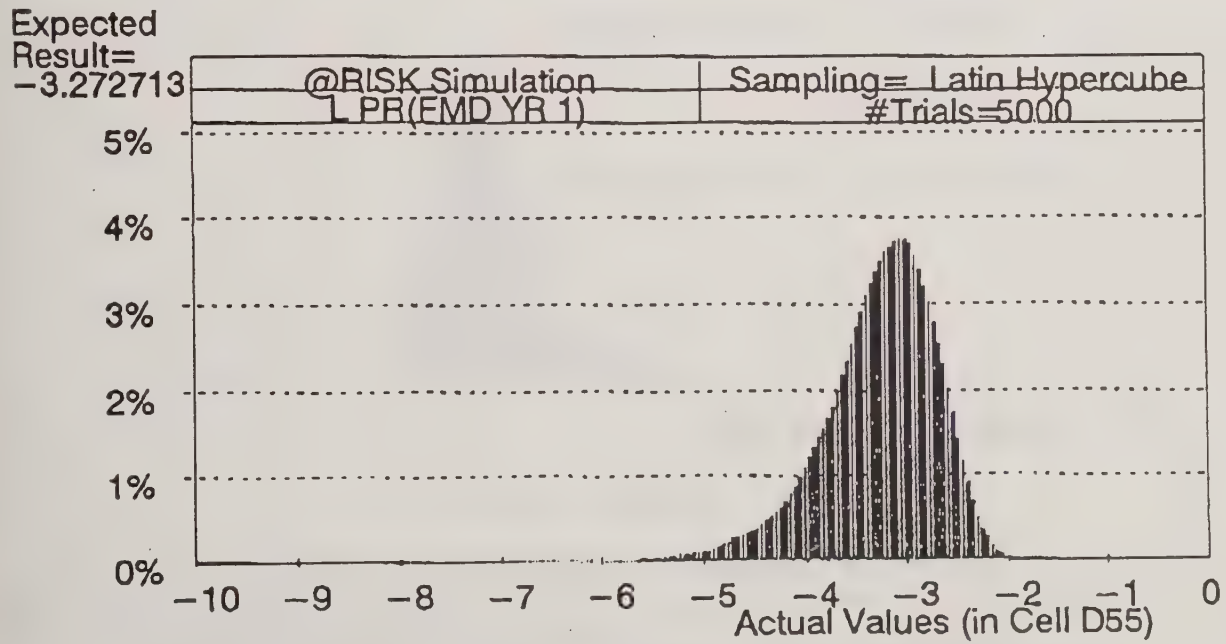
Log of Probability

Cumulative distribution for annual probability that one or more FMD−contaminated sides of beef are exported in one year.



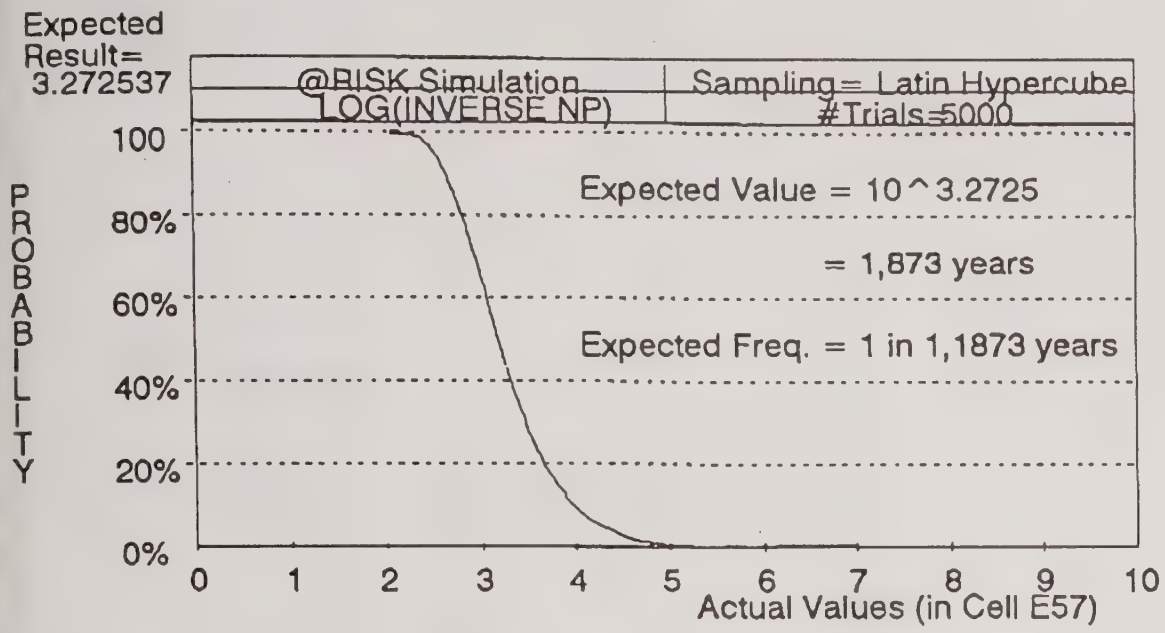
log of annuall probability of >= 1 FMD+ side exported
(Sum of all pathways)

Distribution for annual probability that one or more FMD−contaminated sides of beef are exported in one year.



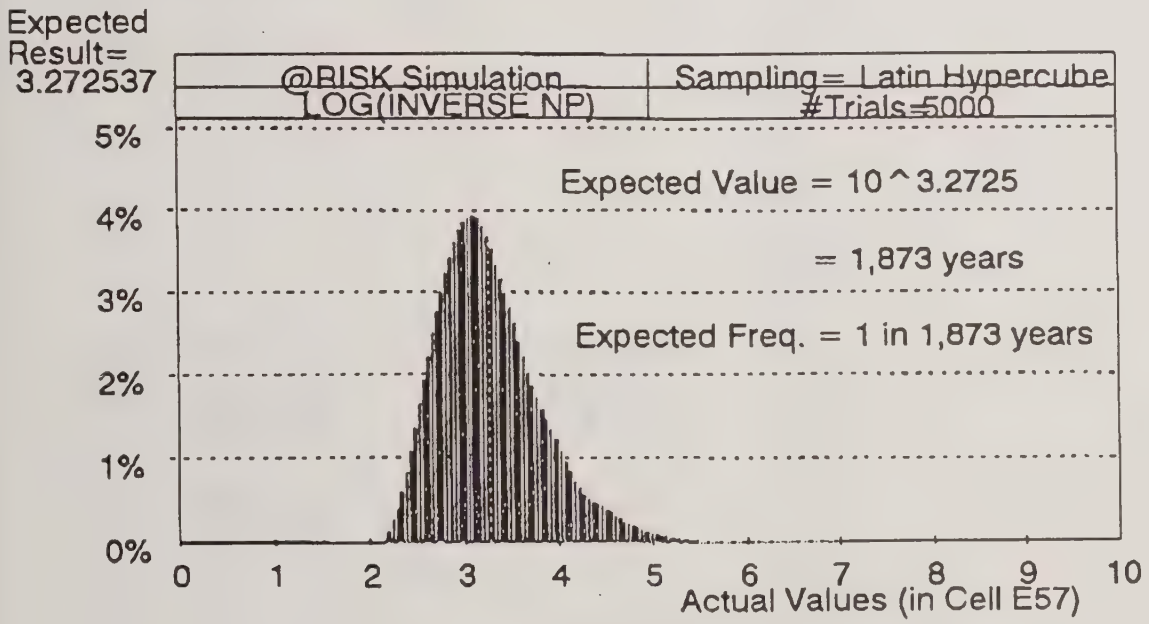
log of annuall probability of >= 1 FMD+ side exported
(Sum of all pathways)

Exceedence distribution for frequency of FMD–contaminated beef exported to United States from Argentina. 1/



Log of Years 2/

Probability distribution for frequency of FMD–contaminated beef exported to United States from Argentina. 1/



Log of Years 2/

1/ Exceedence graph illustrates the likelihood that variable will exceed the x–axis value; for example, there is 40% chance the inverse of the frequency of FMD–contaminated beef is exported exceeds 10^3.27 or 1,873 years. Thus there is 40% probability that FMD–contaminated beef would be exported less frequently than 1 in 1,873 years.

2/ Values on x–scale indicate log of years, e.g., "3" indicates 10^3 or 1,000.

Simulation Statistics for Model Variables for Estimating Frequency of Exporting FMD–Contaminated Beef from Argentina to the United States. 1/

Statistic 2/	Pathway 1 log	Pathway 1 nominal	Pathway 2 log	Pathway 2 nominal	Pathway 3 log	Pathway 3 nominal	Sum of Pathways log	Sum of Pathways nominal
mean	−11.15	7.1E−12	−9.46	3.5E−10	−12.16	6.9E−13	−9.46	3.5E−10
minimum	−14.75	1.8E−15	−13.42	3.8E−14	−16.65	2.2E−17	−13.4	4.0E−14
maximum	−9.76	1.7E−10	−8.56	2.8E−09	−10.76	1.7E−11		1.0E+00
X_5%	−12.24	5.8E−13	−10.47	3.4E−11	−13.31	4.9E−14	−10.45	3.5E−11
X_95%	−10.35	4.5E−11	−8.84	1.4E−09	−11.28	5.2E−12	−8.83	1.5E−09

Statistic 1/	Pr(FMD export in 1 yr) log	Pr(FMD export in 1 yr) nominal	Inverse of Expected Value of Distribution for 1 Year log	Inverse of Expected Value of Distribution for 1 Year nominal	Average Frequency
mean	−3.27	5.4E−04	3.27	1,862	1 in 1,862 years
minimum	−7.03	9.3E−08	2.01	102	1 in 102 years
maximum	−2.01	9.8E−03	7.03	10,715,193	1 in 10,715,193 years
X_5%	−4.23	5.9E−05	2.52	331	1 in 301 years
X_95%	−2.52	3.0E−03	4.31	20,417	1 in 20,417 years

1/ Pathways refer to spefic routes of entry as described in the scenario tree (Figure 1).
2/ X_5% refers to the 5% fractile of the cumulative distribution; X_95% refers to the 95% fractile of the cumulative distribution.

REFERENCES

1. Situation of the Foot-and-Mouth Control Programs in South America, 1996. Pan American Health Organization, Tenth Inter-American Meeting on Animal Health at the Ministerial Level, April 27, 1997.

2. DC Blood and OM Radostits. Veterinary Medicine, 7th. ed., 1989.

3. H Metcalf and J Blackwell. Back-to-Office Report on 1994 Site Visit to Argentina. 1994.

4. Government of Argentina. Analysis of BSE Risk Factors in Argentina. http://mecon.ar/Agricultura/azseg2.htm. 1997

5. International Organization of Epizootics. Annual meeting, Paris. 1997.

6. GE Cottral, BF Cox and DE Baldwin. The Survival of foot-and-mouth disease virus in cured and uncured meat. Am J Vet Res 21:288-297, 1960.

7. J Blackwell. Personal communication.

8. R McDowell. Personal communication.

9. M Malik. Personal communication.

10. M Garcia. Personal communication.

[illegible] 26. [illegible] American [illegible] Organization [illegible] Animal Health at the National Level.

[illegible] and E. Radostits. Veterinary Medicine [illegible]

[illegible] and J. Blackwell. Back-to-Basics [illegible] to Agriculture. 19[illegible]

[illegible] Argentina. Analysis of [illegible]

[illegible] national Organization of Epizootics. [illegible] 37.

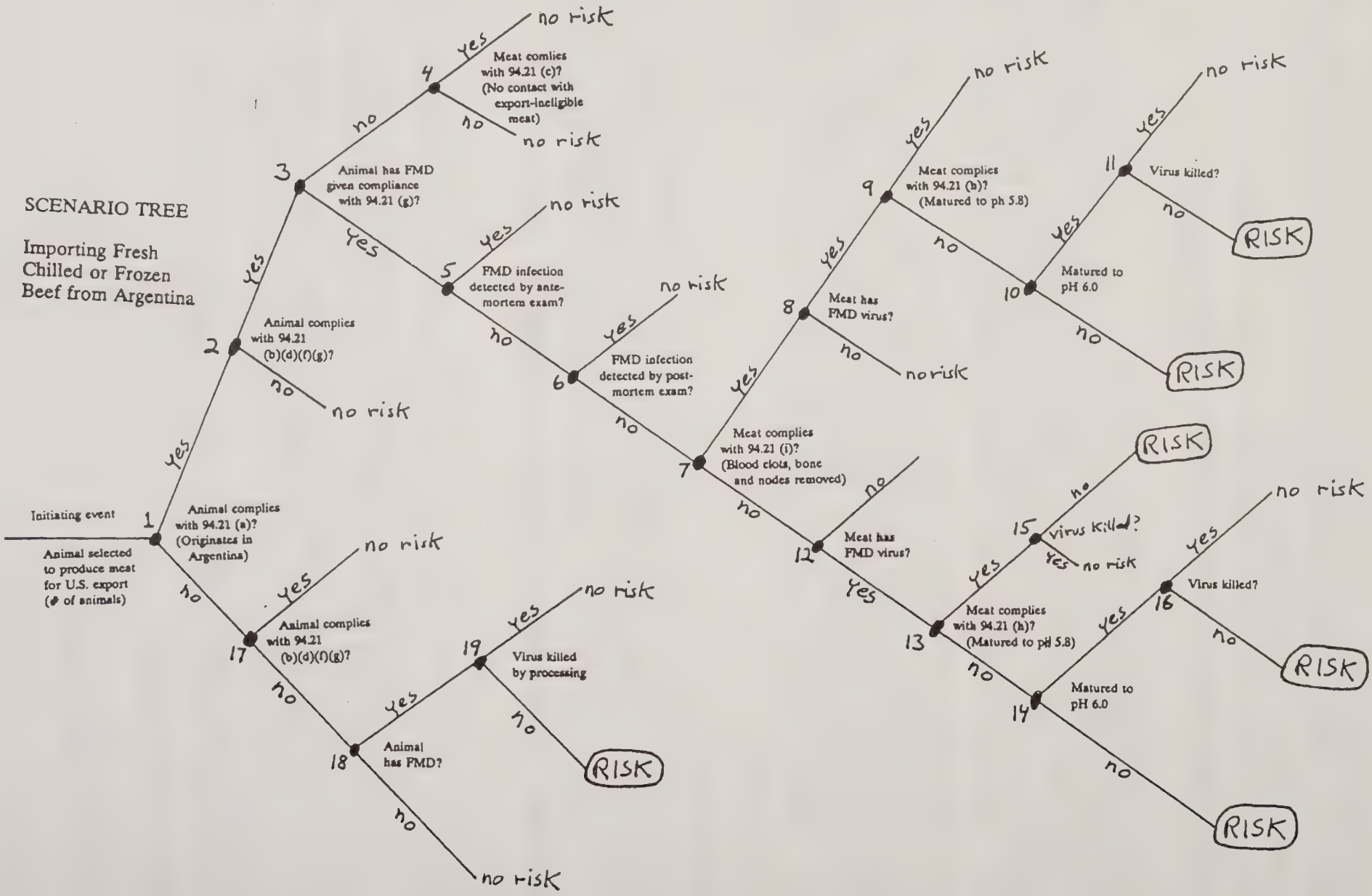
[illegible] and [illegible]. The Survival [illegible] disease virus in cured and uncured meat. [illegible] 1980.

[illegible]. Personal communication.

[illegible] I. Personal communication.

[illegible]. Personal communication.

[illegible] Personal communication.



ARGENTINE BEEF SCENARIO TREE

Pathways Evaluated

The scenario tree evaluates the as-planned pathway plus the following unplanned pathways:

A. Non-Argentine-origin beef is smuggled into Argentina, then shipped to U.S. as Argentine-origin beef;
B. Blood clots, bone, or lymph nodes are not removed as required;
C. If meat is not matured to 5.8, meat is matured to 6.0;
D. If not matured to 6.0, meat is not matured at all.

Other unplanned pathways are of course possible but resources are limited.

Statement of Hazardous Activity and Undesired Outcome:

Given that the U.S. imports 20,000 tons of fresh, chilled, or frozen beef from Argentina according to APHIS's proposed rule and existing FSIS regulations, what is the probability that some or all of the meat will be contaminated with FMD virus? Given that some or all of the meat is contaminated, what quantity of meat is contaminated?

Assumptions:

1. Given that an FMD infected animal is slaughtered for export and processed in such a way that the virus is not killed, all of the meat from that animal is assumed to be FMD contaminated and no meat from any other non-FMD-infected animal is contaminated (i.e., the possibility that only part of the meat from the infected animal is contaminated and the possibility that the contaminated meat contaminates other meat will not be evaluated).

2. It is assumed that non-Argentine animals are not smuggled into Argentina and slaughtered and processed in Argentina for U.S. export. Rather, it is assumed that all non-Argentine animals illegally slaughtered for U.S. export are slaughtered and processed outside of Argentina and the meat (i.e, not the live animal) is smuggled into Argentina. The assumption simplifies the assessment and overestimates the risk.

Explanation and Assumptions at each Branch Point

BP 1 BP 1 is the probability that an animal selected for slaughter and export originates in Argentina.

BP 2 BP 2 is the probability that the animal complies with the required certifications that the meat came from bovines moved

[illegible] the co-[illegible] [illegible] [illegible]
[illegible]

[illegible] is [illegible] into [illegible] then
as [illegible] [illegible]
[illegible] not [illegible]

not matured [illegible], meat is [illegible]
matured to [illegible], meat is not matured [illegible]

[illegible] pathways are of course possible [illegible]

[illegible] and [illegible]

[illegible] that the U.S. imports 24,000 tons of [illegible]
[illegible]
[illegible] these [illegible], [illegible] probability [illegible]
[illegible] will be [illegible] given that [illegible]
of the meat [illegible], what quantity of meat is infected?

[illegible]:

[illegible] an FMD infected [illegible]
[illegible] in such a way that the virus [illegible]
[illegible] that animal is assumed to [illegible]
[illegible] other [illegible]
[illegible] probability that only part of the [illegible]
[illegible] and the possibility [illegible] rate [illegible]
[illegible] this meat will not be matured)

It assumed that none of the entire animal [illegible]
and [illegible] [illegible] the U.S.
Further, [illegible]
[illegible] or [illegible]
a [illegible] (i.e., not the [illegible]) [illegible]
[illegible] assessment

[illegible]

[illegible]

[illegible] that the meat [illegible]

directly to slaughter without contact with other animals, meat came from bovines originating on premises where FMD and rinderpest have not been present during the lifetime of any bovines slaughtered for export, the meat came from bovines from premises on which modified live or attenuated FMD vaccine has not been used, and the meat came from bovines not vaccinated for rinderpest. The risk assessment will specify a probability of 1 that the certifications are true. Therefore the "no" pathway at this node has no risk. APHIS staff recognize that the "no" pathway may have some risk but it is thought to be small compared to other unplanned pathways that have been evaluated. Resources are limited. (Note that modified live and attenuated FMD vaccine is illegal in Argentina; although 90% of cattle are vaccinated, they are vaccinated with killed vaccine.) Because it was decided not to consider risk pathways originating from the "no" side of this branch point, I considered not including the point in the assessment. It is included to show that all required certifications in the proposed rule were addressed. See also discussion about BP 17.

BP 3 BP 3 is the probability that an animal has FMD given that the GOA certifies that FMD has not been diagnosed within the past 12 months.

BP 4 BP 4 is the probability that meat from non-infected animals comes in contact with non-export-eligible meat. Staff specify a probability of 1. Note that the possibility of smuggled meat is explicitly modeled in the risk assessment and that an assumption is made that meat from infected animals does not contaminate meat from non-infected animals. This node theoretically should be repeated elsewhere in the tree but there would be no point to doing so because other branches in the tree address the issue of contaminated meat. There is no need to model the probability that contaminated meat is further contaminated by adjacent non-export-eligible meat.

BP 5 BP 5 is the probability that an FMD infected animal is detected by ante-mortem inspection.

BP 6 BP 6 is the probability that an FMD infected animal is detected by post-mortem inspection.

BP 7 BP 7 is the probability that blood clots, bones, and lymph nodes are removed as required. BP 7 shifts the focus of the tree from animals to meat. Perhaps a multiplier node (i.e., pounds of meat per animal) should be inserted in the tree between BP 6 and BP 7? Because of the assumption that contaminated meat comes only from infected animals and not from cross contamination, the amount of contaminated meat will be directly porportional to the number of infected animals slaughtered.

BP 8 and 12 BP 8 and 12 is the probability that the meat has virus. The hypothesis is that a FMD-infected animal that is undetected at AM and PM exam is likely to be a chronic asymptomatic not-viremic carrier. If it also has bone and nodes removed, the

[illegible] slaughter [illegible] with [illegible] animals, [illegible] to its nature [illegible] and [illegible] been present during [illegible] meat [illegible] from [illegible] vaccinated [illegible] has not been [illegible] not vaccinated for [illegible] probability [illegible] that the certifications [illegible] the "no" [illegible] that the "no" [illegible] to be small compared to [illegible] Resources [illegible] vaccine [illegible] vaccinated, they are vaccinated [illegible] was decided not to [illegible] value of this [illegible] point [illegible] in the assessment. [illegible] is included [illegible] certifications in the [illegible] about DP 17.

DP 3 is the probability that an animal [illegible] certifies that [illegible] has not been diagnosed [illegible]

DP 4 is the probability that meat [illegible] non-infected [illegible] comes in contact with [illegible] a probability of 1. Note that the possibility [illegible] explicitly modeled in the risk assessment [illegible] is made that meat from infected animals does [illegible] meat from non-infected animals. [illegible] should be regarded elsewhere [illegible] to [illegible] because other [illegible] the [illegible] of contamination [illegible] There is [illegible] probability that [illegible] exported [illegible] meat.

DP 5 is the probability that [illegible] ante-mortem inspection.

[illegible] probability that [illegible] infected animal is [illegible] inspection.

[illegible] blood clots, bones, [illegible] the [illegible] multiplies [illegible] in the [illegible] between [illegible] contaminated [illegible] contamination, the amount [illegible] proportional to the number of

[illegible] probability that the meat [illegible]

probability that the remaining meat is not contaminated may be high. The presence of blood clots, bone, and nodes also affects the probabilities at BP 9 and 13 which is why the tree does not converge at these nodes.

BP 9 and 13 BP 9 and 13 are the probabilities that the meat is matured to pH 5.8. Because the pH of blood clots, bones, and nodes does not decrease as readily as muscle tissue, the yes and no pathways at BP 7 are kept separate rather than converging. Whereas the yes pathway at BP 9 is assumed to lead to no risk, the yes pathway at BP 13 is not assumed to lead to no risk because clots, bone, and nodes are present.

BP 10 and 14 BP 10 and 14 are the probabilities that the meat is matured to pH 6.0.

BP 11 BP 11 is the probability that the virus is killed at pH 6.0. Any suggestions for evidence on quantifying this will be appreciated.

BP 15 BP 15 is the probability that virus is killed, given that clots, bones, or nodes are not removed and meat is aged to pH 5.8.

BP 16 BP 16 is the probability that virus is killed, given maturation only to 6.0 and clots, bones, or nodes are not removed.

BP 17 BP 17 is the probability that meat complies with certifications 94.21 (b)(d)(f)(g). Staff specify probability of 1 for "no" pathway. Whereas at BP 2, 100% compliance is assumed, because the animals at BP 17 are illegal, zero compliance is assumed. Because all the animals are assumed to not be in compliance, there is no risk from animals in compliance. (If there were a greater-than-zero probability for the "yes" pathway at BP 17, this pathway would have to be extended. Perhaps it might be better not to include this node in the tree. I put it in to clearly indicate the assumption that all smuggled animals and meat from smuggled animals is not in compliance with required certifications.)

BP 18 BP 18 is the probability that the illegal animal/meat from illegal animal has FMD. Although illegal the probability is still expected to be low.

BP 19 BP 19 is the probability that the meat from the illegal animal is contaminated with FMD after processing. Because the meat is illegal, we have no idea precisely what processing it received, i.e., whether it received AM and PM inspection, whether clots, bones, nodes were removed, or if it was matured at all, let alone to pH 5.8. I saw no point in separating this node into smaller parts.

[illegible] The [illegible] and 12 which is [illegible] at these nodes.

[illegible] 8 and 13 are the probabilities that [illegible] ured to pH 5.8, [illegible] not decrease [illegible] at BP 7 [illegible] away at BP 9 is assumed to [illegible] BP 13 is not [illegible] to lead to no risk [illegible] nodes are present.

[illegible] 10 and 14 are the probabilities that [illegible] natured [illegible].

[illegible] is the probability that [illegible] by [illegible] evidence on quantifying this [illegible] stated.

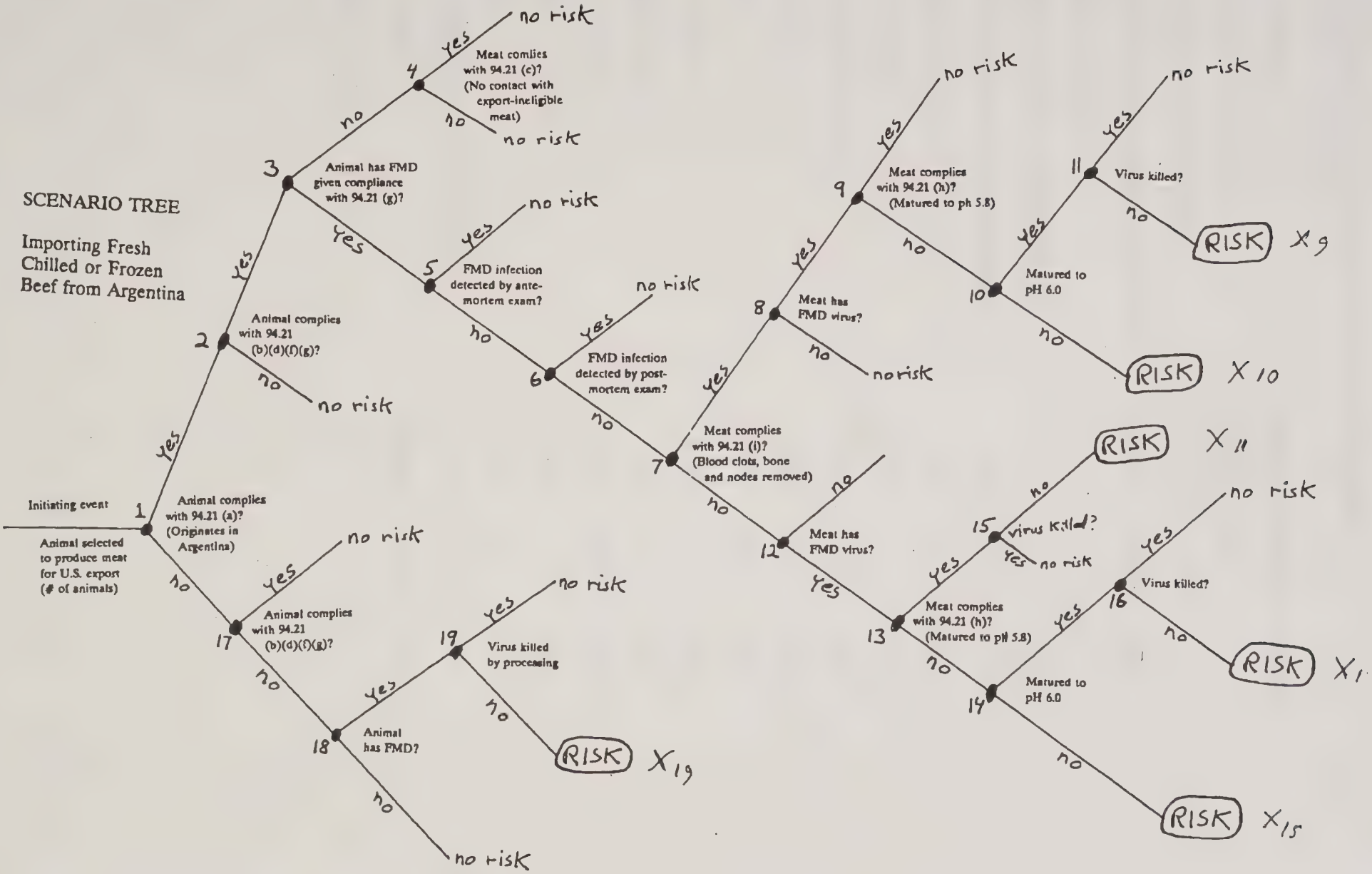
BP 15 is the probability that [illegible] nodes are not removed [illegible]

BP 16 is the probability that [illegible] from only to [illegible]

BP [illegible] is the probability that [illegible] compliance [illegible] tion 94 [illegible] (b)(3)(5)(9) [illegible] specify probability [illegible] no [illegible] Whereas at BP 2, 1991 compliance is [illegible] animals [illegible] illegal, zero compliance [illegible] there is no [illegible] in compliance [illegible] then zero probability for the "good" pathway [illegible] would have [illegible] extended [illegible] it might be [illegible] to [illegible] tree. I put it [illegible] the one [illegible] all smuggled entire [illegible] animals is not in compliance with requirements.

[illegible] probability that the illegal animal/meat [illegible] PM. Although illegal, the probability is low.

[illegible] probability that the meat from the illegal [illegible] process [illegible]. Because the meat [illegible] when processing it received [illegible] PM inspection, whether [illegible] is measured at all. [illegible] in separating this node into [illegible]


SCENARIO TREE
Importing Fresh Chilled or Frozen Beef from Argentina
Initiating event
Animal selected to produce meat for U.S. export (# of animals)
1 Animal complies with 94.21 (a)? (Originates in Argentina)
2 Animal complies with 94.21 (b)(d)(f)(g)?
3 Animal has FMD given compliance with 94.21 (g)?
4 Meat comlies with 94.21 (c)? (No contact with export-ineligible meat)
5 FMD infection detected by ante-mortem exam?
6 FMD infection detected by post-mortem exam?
7 Meat complies with 94.21 (i)? (Blood clots, bone and nodes removed)
8 Meat has FMD virus?
9 Meat complies with 94.21 (h)? (Matured to ph 5.8)
10 Matured to pH 6.0
11 Virus killed?
12 Meat has FMD virus?
13 Meat complies with 94.21 (h)? (Matured to pH 5.8)
14 Matured to pH 6.0
15 virus killed?
16 Virus killed?
17 Animal complies with 94.21 (b)(d)(f)(g)?
18 Animal has FMD?
19 Virus killed by processing
yes
no
no risk
RISK
X9
X10
X11
X1
X15
X19

Prepared by Craig Chioino 6/10/97 - 4:17 PM

INTRODUCTION OF FMD FROM IMPORTATION OF BEEF FROM ARGENTINA
VALUE OF INPUT VARIABLES

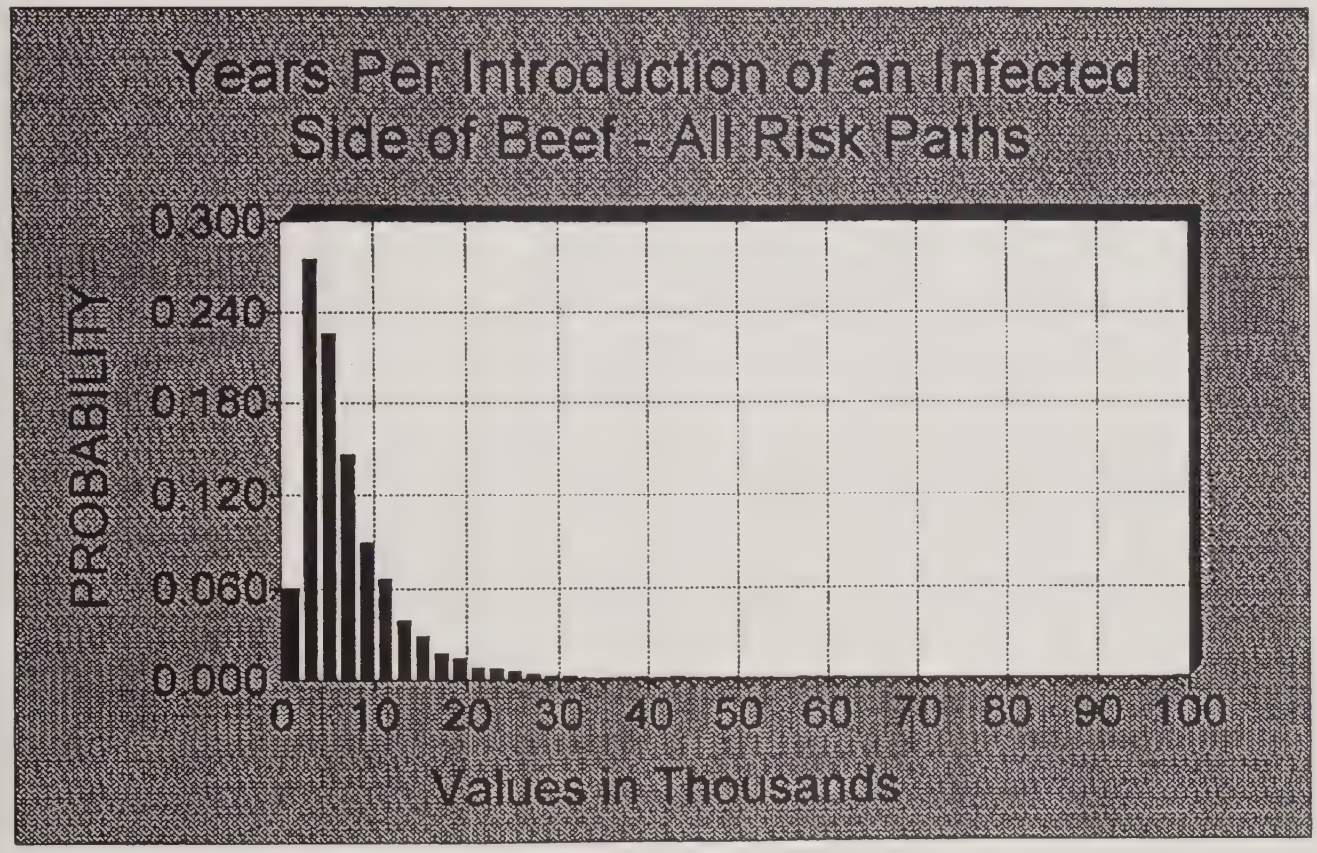
Estimates Of Input Variables		Minimum	MostLikely	Maximum
f1	Animal complies with 94.21 (a)	0.99	0.9995	1
f2	Animal complies with 94.21 (b)(d)(f)(g)	1	1	1
f3	Animal has FMD given compliance with 94.21(g)	5.00E-09	5.00E-08	1.00E-07
f4	Meat complies with 94.21 ( )	1	1	1
f5	FMD infection detected by ante-mortem exam	0.5	0.7	0.9
f6	FMD infection detected by post-mortem exam	0.05	0.1	0.2
f7	Meat complies with 94.21 ( )	0.98	0.99	0.999
f8	Meat has FMD virus	0.05	0.1	0.15
f9	Meat complies with 94.21 (h)	0.8	0.9	0.99
f10	Matured to pH 6.0	0.99	0.995	0.999
f11	Virus killed	0.8	0.9	0.99
f12	Meat has FMD virus	0.25	0.5	0.75
f13	Meat complies with 94.21 (h)	0.8	0.9	0.99
f14	Matured to pH 6.0	0.99	0.995	0.999
f15	Virus killed	0.05	0.1	0.2
f16	Virus killed	0.05	0.1	0.2
f17	Animal complies with 94.21 (b)(d)(f)(g)	0	0	0
f18	Animal has FMD	5.00E-08	5.00E-07	1.00E-06
f19	Virus killed by processing	0.7	0.8	0.9

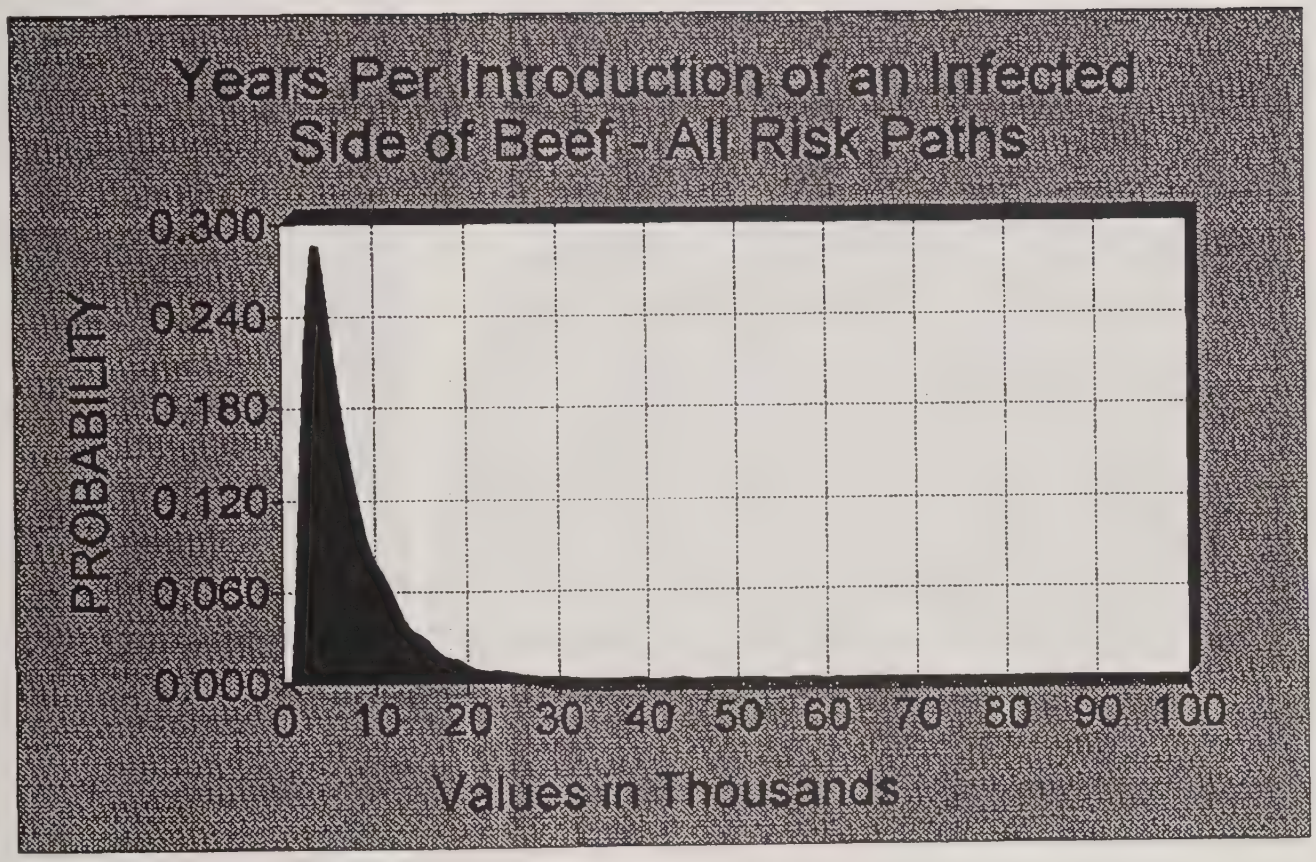
	A	B	C	D	E	F	G	H	I	J	K	L	M
1	INTRODUCTION OF FMD FROM IMPORTATION OF BEEF FROM ARGENTINA												
2		CORRESPONDS TO SCENARIO TREE											
3													
4	Estimates Of Input Variables												
5													
6		Total volume of slaughtered meat year in metric tons						20000					
7													
8		Maximum - Kg of slaughtered meat per animal						100					
9													
10		Most likely - Kg of slaughtered meat per animal						50					
11													
12		Minimum - Kg of slaughtered meat per animal						10					
13													
14		Minimum - number of animals slaughtered per year							200000	=H6*1000/H8			
15													
16		Most likely - number of animals slaughtered per year							400000	=H6*1000/H10			
17													
18		Maximum - number of animals slaughtered per year							2000000	=H6*1000/H12			
19													
20	c1	Number of sides per animal						2					
21													
22	v1	Number of animals slaughtered per year						866666.7	=RiskTriang(I14,I16,I18)				
23													
24	f1	Animal complies with 94.21 (a)						0.9995	=RiskTriang(0.999,0.9995,1)				
25													
26	f2	Animal complies with 94.21 (b)(d)(f)(g)						1					
27													
28	f3	Animal has FMD given compliance with 94.21(g)						5.17E-08	=RiskTriang(0.000000005,0.00000005,0.0000001)				
29													
30	f4	Meat complies with 94.21 ©						1					
31													
32	f5	FMD infection detected by ante-mortem exam						0.7	=RiskTriang(0.5,0.7,.9)				
33													
34	f6	FMD infection detected by post-mortem exam						0.116667	=RiskTriang(0.05,0.1,.2)				
35													
36	f7	Meat complies with 94.21 (l)						0.989667	=RiskTriang(0.98,0.99,.999)				
37													
38	f8	Meat has FMD virus						0.1	=RiskTriang(0.05,0.1,.15)				
39													
40	f9	Meat complies with 94.21 (h)						0.896667	=RiskTriang(0.8,0.9,.99)				

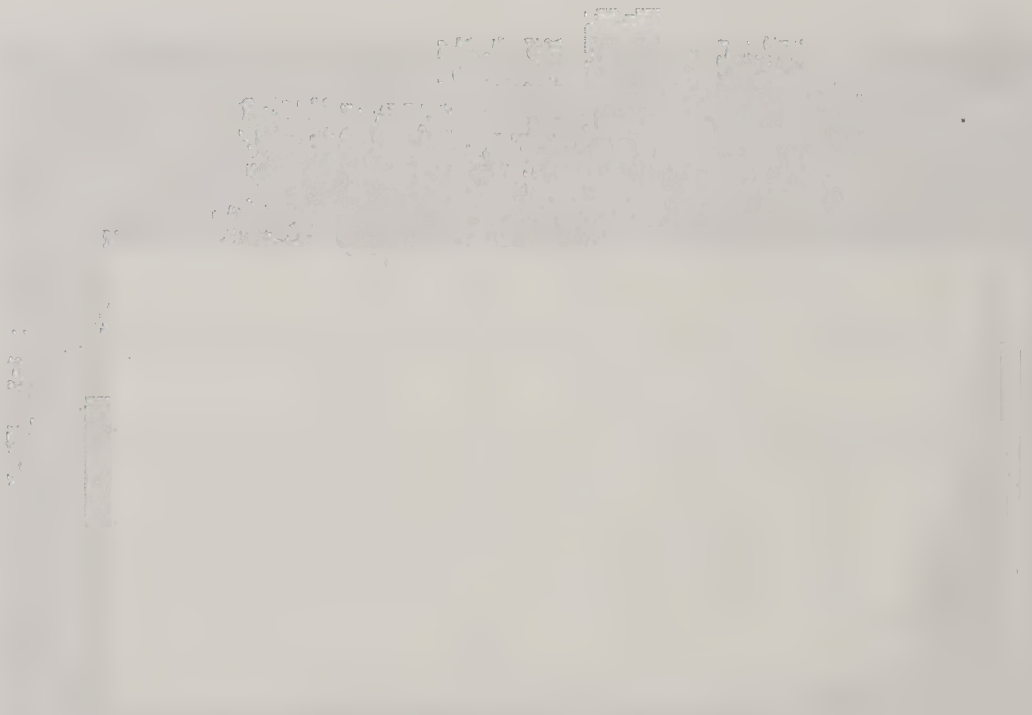
	A	B	C	D	E	F	G	H	I	J	K	L	M
41													
42	f10	Matured to pH 6.0						0.994667	=RiskTriang(0.99,0.995,.999)				
43													
44	f11	Virus killed						0.896667	=RiskTriang(0.8,0.9,.99)				
45													
46	f12	Meat has FMD virus						0.5	=RiskTriang(0.25,0.5,.75)				
47													
48	f13	Meat complies with 94.21 (h)						0.896667	=RiskTriang(0.8,0.9,.99)				
49													
50	f14	Matured to pH 6.0						0.994667	=RiskTriang(0.99,0.995,.999)				
51													
52	f15	Virus killed						0.116667	=RiskTriang(0.05,0.1,.2)				
53													
54	f16	Virus killed						0.116667	=RiskTriang(0.05,0.1,.2)				
55													
56	f17	Animal complies with 94.21 (b)(d)(f)(g)						0					
57													
58	f18	Animal has FMD						5.17E-07	=RiskTriang(0.00000005,0.0000005,0.000001)				
59													
60	f19	Virus killed by processing						0.8	=RiskTriang(0.7,0.8,.9)				
61													

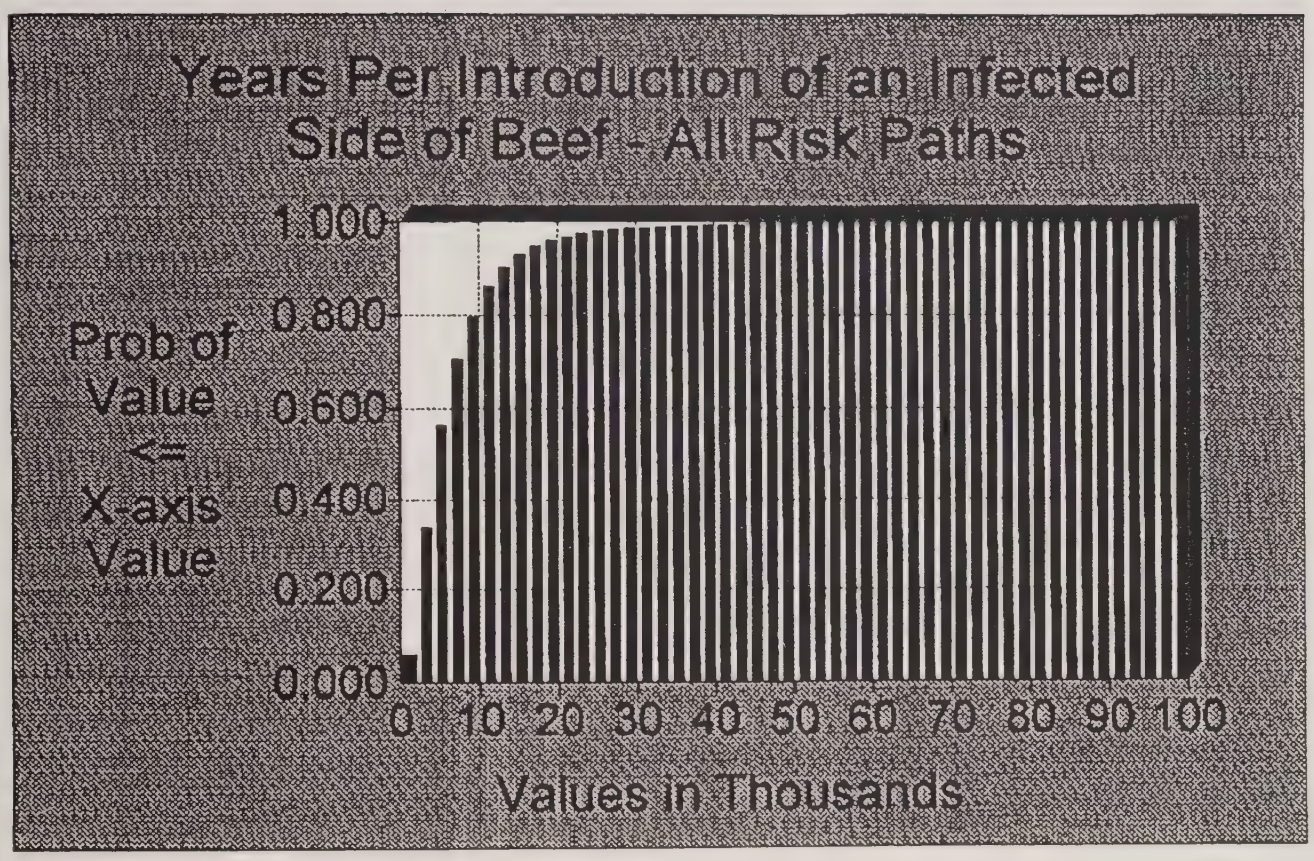
	A	B	C	D	E	F	G	H	I	J	K	L	M
62	**Estimates Of Output Variables**												
63													
64	x1 = v1 * f1 * f2 * (1-f3) * f4								866233.3				
65													
66	x2 = v1 * f1 * f2 * (1-f3) * (1-f4)								0				
67													
68	x3 = v1 * f1 * f2 * f3 * f5								0.031329				
69													
70	x4 = v1 * f1 * f2 * f3 * (1-f5) * f6								0.001586				
71													
72	x5 = c1 * v1 * f1 * f2 * f3 * (1-f5) * (1-f6) * f7 * f8 * f9								0.002105				
73													
74	x6 = c1 * v1 * f1 * f2 * f3 * (1-f5) * (1-f6) * f7 * (1-f8)								0.021128				
75													
76	x7 = c1 * v1 * f1 * f2 * f3 * (1-f5) * (1-f6) *(1-f7) * (1-f12)								0.000123				
77													
78	x8 = c1 * v1 * f1 * f2 * f3 * (1-f5) * (1-f6) * f7 * f8 * (1-f9) * f10 * f11								0.000216				
79													
80	x9 = c1 * v1 * f1 * f2 * f3 * (1-f5) * (1-f6) * f7 * f8 * (1-f9) * f10 * (1-f11)								2.49E-05				
81													
82	x10 = c1 * v1 * f1 * f2 * f3 * (1-f5) * (1-f6) * f7 * f8 * (1-f9) * (1-f10)								1.29E-06				
83													
84	x11 = c1 * v1 * f1 * f2 * f3 * (1-f5) * (1-f6) *(1-f7) * f12 * f13 * (1-f15)								9.71E-05				
85													
86	x12 = c1 * v1 * f1 * f2 * f3 * (1-f5) * (1-f6) *(1-f7) * f12 * f13 * f15								1.28E-05				
87													
88	x13 = c1 * v1 * f1 * f2 * f3 * (1-f5) * (1-f6) *(1-f7) * f12 * (1-f13) * f14 * f16								1.47E-06				
89													
90	x14 = c1 * v1 * f1 * f2 * f3 * (1-f5) * (1-f6) *(1-f7) * f12 * (1-f13) * f14 * (1-f16)								1.11E-05				
91													
92	x15 = c1 * v1 * f1 * f2 * f3 * (1-f5) * (1-f6) *(1-f7) * f12 * (1-f13) * (1-f14)								6.75E-08				
93													
94	x16 = v1 * f1 * (1-f2)								0				
95													
96	x17 = v1 * (1-f1) * f17								0				
97													
98	x18 = c1 * v1 * (1-f1) * (1-f17) * f18 * f19								0.000358				
99													
100	x19 = c1 * v1 * (1-f1) * (1-f17) * f18 * (1-f19)								8.96E-05				
101													

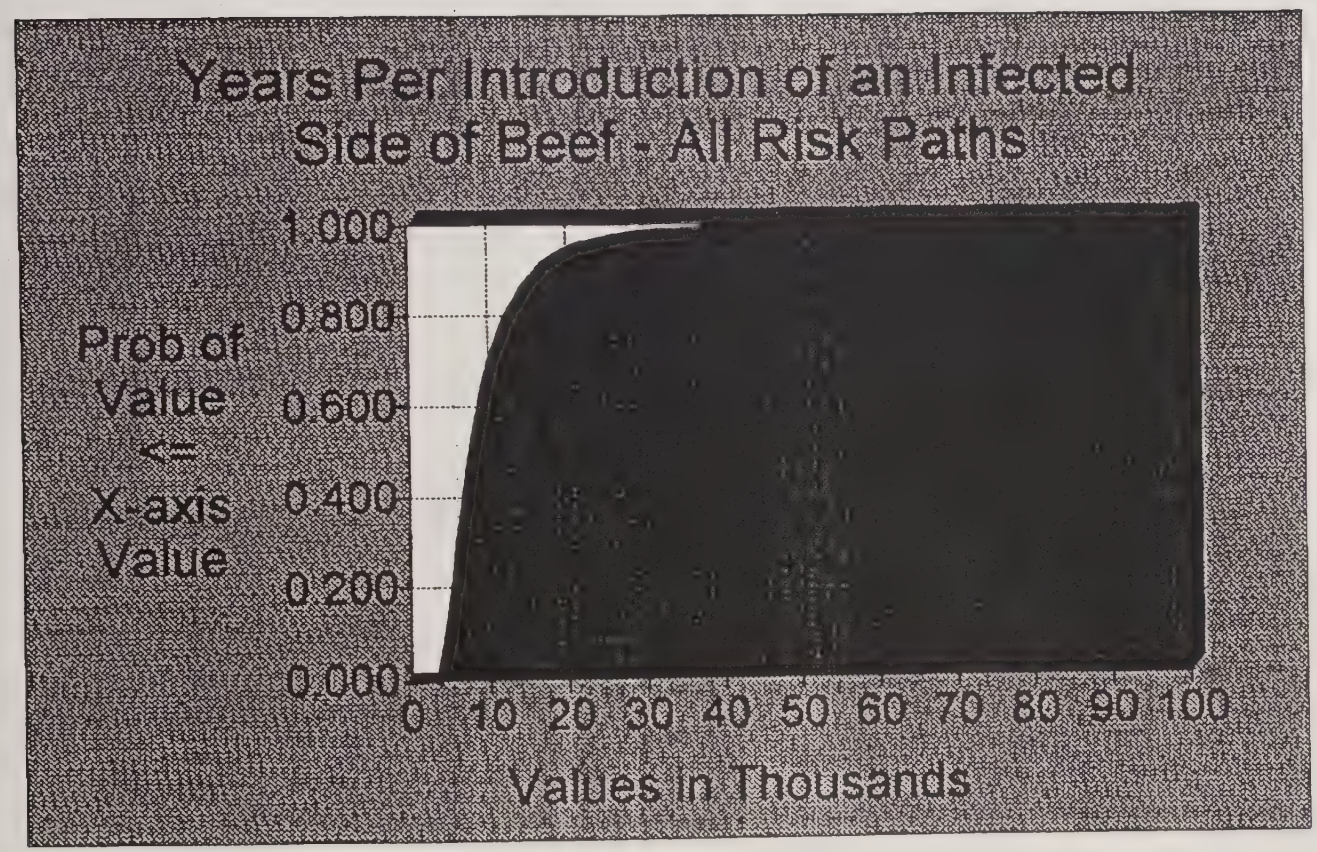
	A	B	C	D	E	F	G	H	I	J	K	L	M
102	x20 = c1 * v1 * (1-f1) * (1-f17) * (1-f18)								866.6662				
103													
104	**Summation Of Risk Output Variables**												
105													
106	Risk paths (x9 + x10 + x11 + x14 + x15 + x19) Infected sides of beef per year								0.000224				
107													
108	Years per introduction of infected side of beef - Risk paths								4463.351	=1/I106			
109													
110	Years per introduction of infected side of beef - x9								40108.04	=1/I80			
111													
112	Years per introduction of infected side of beef - x10								772948.7	=1/I82			
113													
114	Years per introduction of infected side of beef - x11								10301.79	=1/I84			
115													
116	Years per introduction of infected side of beef - x14								89872.27	=1/I90			
117													
118	Years per introduction of infected side of beef - x15								14805708	=1/I92			
119													
120	Years per introduction of infected side of beef - x19								11166.25	=1/I100			


Years Per Introduction of an Infected Side of Beef - All Risk Paths
PROBABILITY
0.300
0.240
0.180
0.120
0.060
0.000
0
10
20
30
40
50
60
70
80
90
100
Values in Thousands


Years Per Introduction of an Infected Side of Beef - All Risk Paths
PROBABILITY
0.300
0.240
0.180
0.120
0.060
0.000
0
10
20
30
40
50
60
70
80
90
100
Values in Thousands




Years Per Introduction of an Infected Side of Beef - All Risk Paths
Prob of Value <= X-axis Value
1.000
0.800
0.600
0.400
0.200
0.000
0 10 20 30 40 50 60 70 80 90 100
Values in Thousands


Years Per Introduction of an Infected Side of Beef - All Risk Paths
Prob of Value <= X-axis Value
1.000
0.800
0.600
0.400
0.200
0.000
0 10 20 30 40 50 60 70 80 90 100
Values in Thousands

Summary Statistics

Simulation Results for Fmdbef00.xls

Iterations= 5000
Simulations= 1
# Input Variables= 17
# Output Variables= 7
Sampling Type= Latin Hypercube
Runtime= 00:02:44
Run on 6/10/97 at 3:48:41 PM

Summary Statistics

Cell	Name	Minimum	Mean	Maximum
I108	YrRiskPat	635.1699	7166.292	98412.71
I110	YrX9	2995.353	108384.7	4004565
I112	YrX10	59621.87	1941970	5.72E+07
I114	YrX11	992.8755	22919.97	561355.2
I116	YrX14	8229.686	245306.7	1.12E+07
I118	YrX15	954195.6	4.68E+07	1.98E+09
I120	YrX19	1375.324	24993.45	1627738
H22	(Input) Nu	205948.7	866666.2	1985357
H24	(Input) Ani	0.99901	0.9995	0.999992
H28	(Input) Ani	5.68E-09	5.17E-08	9.94E-08
H32	(Input) FM	0.502343	0.7	0.897016
H34	(Input) FM	5.11E-02	0.116667	0.199177
H36	(Input) Me	0.980158	0.989667	0.998831
H38	(Input) Me	5.03E-02	0.1	0.149571
H40	(Input) Me	0.800853	0.896667	0.989505
H42	(Input) Ma	0.990092	0.994667	0.998968
H44	(Input) Vir	0.801503	0.896667	0.988792
H46	(Input) Me	0.254916	0.499999	0.745408
H48	(Input) Me	0.801666	0.896667	0.988275
H50	(Input) Ma	0.990068	0.994667	0.998952
H52	(Input) Vir	5.02E-02	0.116667	0.19952
H54	(Input) Vir	5.05E-02	0.116667	0.199835
H58	(Input) Ani	5.34E-08	5.17E-07	9.96E-07
H60	(Input) Vir	0.701844	0.8	0.898085

Detail Statistics

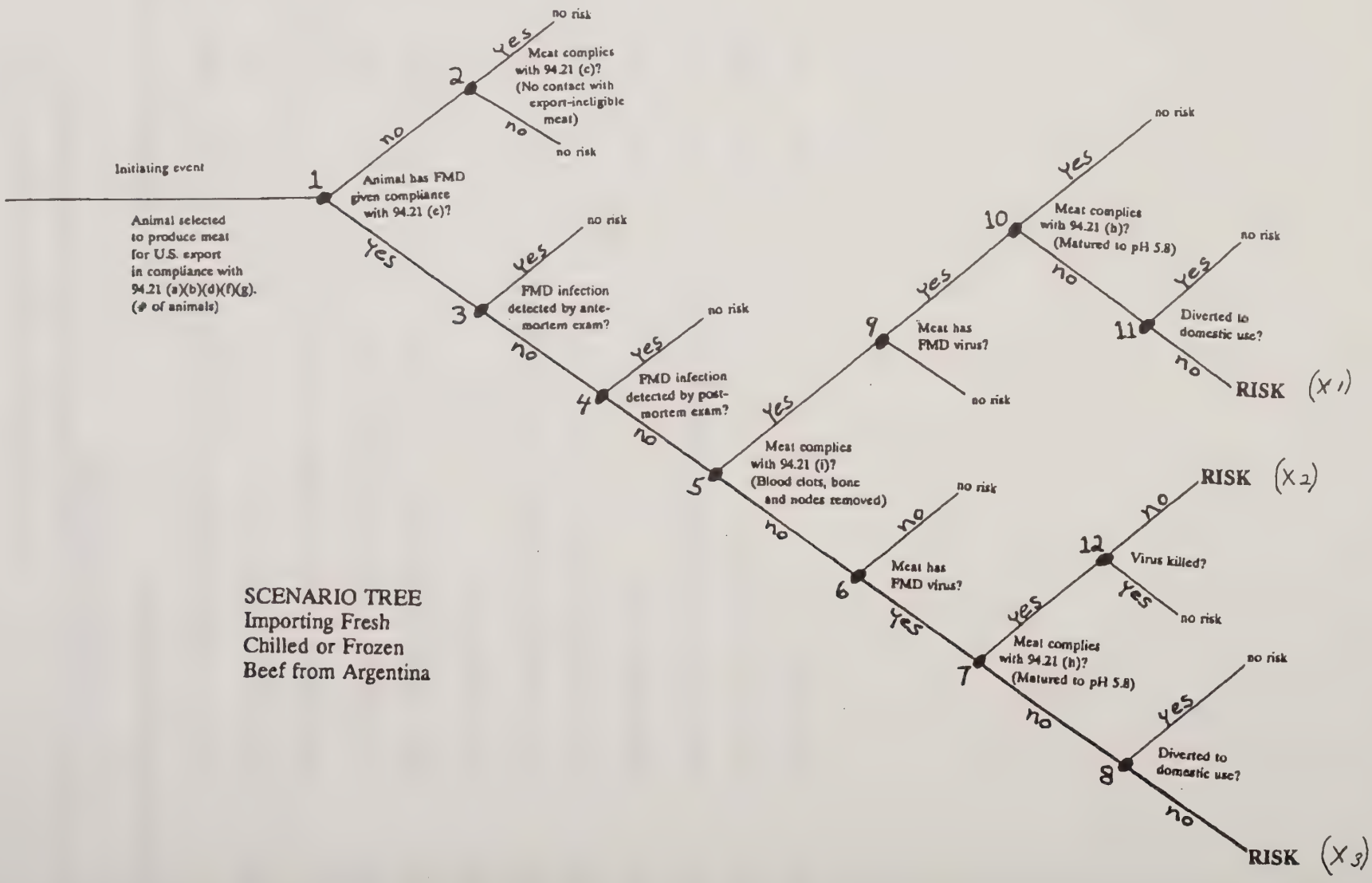
@RISK Si	Run on 6/	Simulation Iterations=						
Name	YrRiskPat	YrX9	YrX10	YrX11	YrX14	YrX15	YrX19	Number of
Descriptio	Output	Output	Output	Output	Output	Output	Output	Triang(I14
Cell	I108	I110	I112	I114	I116	I118	I120	H22
Minimum	635.1699	2995.353	59621.87	992.8755	8229.686	954195.6	1375.324	205949.7
Maximum	98412.71	4004565	5.72E+07	561355.2	1.12E+07	1.98E+09	1627738	1985357
Mean =	7166.292	108384.7	1941970	22919.97	245306.7	4.68E+07	24993.45	866666.2
Std Deviat	6137.064	178200.3	2684490	31355.41	410852.4	8.42E+07	44644.87	402773
Variance	3.77E+07	3.18E+10	7.21E+12	9.83E+08	1.69E+11	7.10E+15	1.99E+09	1.62E+11
Skewness	3.416613	8.400784	5.692436	6.002847	9.602198	7.986534	14.76216	0.539671
Kurtosis =	25.29694	129.8809	65.89257	63.42186	184.1304	111.9622	401.0928	2.40011
Errors Cal	0	0	0	0	0	0	0	0
Mode =	2574.66	34487.08	1827720	7229.337	66560.49	1.20E+07	7828.676	412556.8
5% Perc =	1921.367	13956.88	263327.3	3806.074	29982.27	4651630	4227.793	334124.3
10% Perc	2322.137	18305.9	347328.6	4791.561	40079.19	6471647	5299.162	389680.1
15% Perc	2669.537	22430.71	434700.8	5835.84	49337.05	8165916	6311.544	435272.6
20% Perc	3033.141	26748.42	513289.6	6790.046	59933.06	9862155	7320.496	481926.7
25% Perc	3368.425	30473.16	599933.3	7804.795	68955.8	1.18E+07	8299.312	530294.1
30% Perc	3753.73	35168.98	690241.6	8871.402	78702.14	1.37E+07	9483.046	579947.1
35% Perc	4096.316	40188.81	782296.5	9940.805	89532.13	1.54E+07	10600.2	631605.5
40% Perc	4510.358	45253.41	884224.4	11245.96	102975.2	1.75E+07	11922.73	685315.3
45% Perc	4944.087	50858.64	998277.6	12588.37	118190.5	1.99E+07	13168.96	741254.6
50% Perc	5417.097	58054.49	1121226	13899.61	131486.9	2.30E+07	14721.11	799763
55% Perc	5887.958	66740.99	1260753	15574.48	147091.1	2.62E+07	16413.11	861560.1
60% Perc	6424.954	76368.2	1436565	17401.46	166944.7	3.01E+07	18231.78	926476.2
65% Perc	7105.014	87557.05	1636504	19691.12	191876.9	3.47E+07	20465.02	995952.9
70% Perc	7884.899	100884	1874677	22559.43	223326.7	4.16E+07	23354.25	1070414
75% Perc	8850.382	118036.6	2201765	25926.75	259897.7	4.89E+07	27057.12	1151133
80% Perc	10111.42	139862	2651569	30184.58	310459	5.95E+07	31861.63	1240840
85% Perc	11546.24	173439	3222126	36616.55	393376.7	7.70E+07	38242.77	1342501
90% Perc	13818.82	226837	4206896	47159.77	539414.5	1.04E+08	48568.14	1463092
95% Perc	18057.91	356250.8	6230159	69060.05	838395.5	1.60E+08	76651.16	1620186
Filter Minimum =								
Filter Maximum =								
Type (1 or 2) =								
# Values F	0	0	0	0	0	0	0	0
Scenario #	>75%	>75%	>75%	>75%	>75%	>75%	>75%	
Scenario #	<25%	<25%	<25%	<25%	<25%	<25%	<25%	
Scenario #	>90%	>90%	>90%	>90%	>90%	>90%	>90%	

Detail Statistics

Animal co Triang(0.9 H24	Animal ha Triang(0.0 H28	FMD infec Triang(0.5 H32	FMD infec Triang(0.0 H34	Meat com Triang(0.9 H36	Meat has Triang(0.0 H38	Meat com Triang(0.8 H40	Matured to Triang(0.9 H42	Virus kille Triang(0.8 H44
0.99901	5.68E-09	0.502343	5.11E-02	0.980158	5.03E-02	0.800853	0.990092	0.801503
0.999992	9.94E-08	0.897016	0.199177	0.998831	0.149571	0.989505	0.998968	0.988792
0.9995	5.17E-08	0.7	0.116667	0.989667	0.1	0.896667	0.994667	0.896667
2.04E-04	1.94E-08	8.16E-02	0.031181	3.88E-03	2.04E-02	0.038802	1.84E-03	0.038802
4.17E-08	3.76E-16	6.67E-03	9.72E-04	1.51E-05	4.17E-04	1.51E-03	3.39E-06	1.51E-03
-1.29E-05	5.15E-02	-7.16E-06	0.30558	-5.14E-02	-6.79E-05	-5.16E-02	-0.10796	-5.15E-02
2.399762	2.399854	2.399911	2.400225	2.399916	2.40014	2.400257	2.400036	2.400128
0	0	0	0	0	0	0	0	0
0.999146	5.01E-08	0.698998	0.100879	0.992307	0.100251	0.899865	0.994586	0.899867
0.999158	1.96E-08	0.563126	6.93E-02	0.983081	6.58E-02	0.830822	0.991498	0.830767
0.999224	2.57E-08	0.589399	7.74E-02	0.984359	7.23E-02	0.843548	0.992121	0.843566
0.999274	3.03E-08	0.609527	8.35E-02	0.985339	7.74E-02	0.853364	0.9926	0.853371
0.999316	3.42E-08	0.626429	8.87E-02	0.986163	8.16E-02	0.861636	0.993	0.861615
0.999354	3.77E-08	0.641374	9.33E-02	0.98689	8.53E-02	0.868897	0.993354	0.868894
0.999387	4.08E-08	0.654869	9.74E-02	0.987551	8.87E-02	0.875489	0.993674	0.875482
0.999418	4.37E-08	0.667315	0.101243	0.988156	9.18E-02	0.881541	0.993969	0.881546
0.999447	4.63E-08	0.678874	0.105117	0.988717	9.47E-02	0.887177	0.994243	0.887158
0.999474	4.89E-08	0.689709	0.108155	0.989246	9.74E-02	0.892457	0.994499	0.892457
0.9995	5.13E-08	0.699983	0.113392	0.989746	1.00E-01	0.89745	0.994743	0.89746
0.999526	5.38E-08	0.710229	0.117842	0.990228	0.102559	0.902274	0.994975	0.902262
0.999553	5.64E-08	0.721113	0.122535	0.99073	0.105276	0.907279	0.995206	0.907293
0.999582	5.92E-08	0.732647	0.127538	0.991263	0.108165	0.912625	0.99545	0.91262
0.999613	6.22E-08	0.745037	0.132909	0.991838	0.11127	0.918359	0.995715	0.918372
0.999646	6.55E-08	0.758552	0.138757	0.992459	0.114639	0.924596	0.996	0.9246
0.999684	6.92E-08	0.773488	0.145201	0.99315	0.118362	0.931516	0.996316	0.931507
0.999726	7.33E-08	0.790429	0.152558	0.993935	0.122605	0.939353	0.996675	0.939341
0.999776	7.82E-08	0.810527	0.16125	0.994862	0.127628	0.948632	0.997101	0.948628
0.999842	8.46E-08	0.836657	0.172596	0.996076	0.134182	0.960721	0.997658	0.960734
0	0	0	0	0	0	0	0	0

Detail Statistics

Meat has	Meat com	Matured to	Virus kille	Virus kille	Animal ha	Virus killed by processing
Triang(0.2	Triang(0.8	Triang(0.9	Triang(0.0	Triang(0.0	Triang(0.0	Triang(0.7,0.8,0.9)
H46	H48	H50	H52	H54	H58	H60
0.254916	0.801666	0.990068	5.02E-02	5.05E-02	5.34E-08	0.701844
0.745408	0.988275	0.998952	0.19952	0.199835	9.96E-07	0.898085
0.499999	0.896667	0.994667	0.116667	0.116667	5.17E-07	0.8
0.102063	3.88E-02	1.84E-03	3.12E-02	3.12E-02	1.94E-07	4.08E-02
1.04E-02	1.51E-03	3.39E-06	9.72E-04	9.72E-04	3.76E-14	1.67E-03
-1.34E-04	-5.16E-02	-0.108	0.305512	0.305511	5.14E-02	-8.58E-05
2.399974	2.399718	2.399973	2.400359	2.400391	2.400045	2.399985
0	0	0	0	0	0	0
0.501256	0.901794	0.994012	0.100879	0.100125	5.05E-07	0.798488
0.328935	0.830794	0.9915	6.93E-02	6.93E-02	1.96E-07	0.731615
0.361753	0.84355	0.99212	7.74E-02	7.74E-02	2.57E-07	0.744684
0.386895	0.853361	0.992599	8.35E-02	8.35E-02	3.03E-07	0.754741
0.408072	0.861639	0.992999	8.87E-02	8.87E-02	3.42E-07	0.763237
0.426742	0.868908	0.993353	9.33E-02	9.33E-02	3.77E-07	0.77071
0.443617	0.875488	0.993675	0.097428	9.74E-02	4.08E-07	0.777436
0.459116	0.881531	0.993969	0.101243	0.101247	4.37E-07	0.78365
0.473579	0.887177	0.994242	0.10513	0.105127	4.63E-07	0.789425
0.487125	0.892463	0.994499	0.109167	0.109164	4.89E-07	0.794852
0.499973	0.897457	0.994743	0.113396	0.113388	5.13E-07	0.8
0.512825	0.902262	0.994975	0.117825	0.117833	5.38E-07	0.805118
0.526379	0.907287	0.995206	0.122533	0.122522	5.64E-07	0.810556
0.540792	0.912637	0.99545	0.127537	0.127529	5.92E-07	0.816319
0.556307	0.918371	0.995715	0.132915	0.132915	6.23E-07	0.822533
0.573156	0.924593	0.996	0.138761	0.138747	6.55E-07	0.829281
0.591853	0.931497	0.996316	0.145208	0.145221	6.92E-07	0.836733
0.613012	0.939339	0.996676	0.152561	0.152551	7.33E-07	0.845209
0.638178	0.948627	0.997102	0.161261	0.161256	7.82E-07	0.855256
0.67092	0.96075	0.997657	0.172562	0.17259	8.46E-07	0.868346
0	0	0	0	0	0	0



SCENARIO TREE
Importing Fresh
Chilled or Frozen
Beef from Argentina

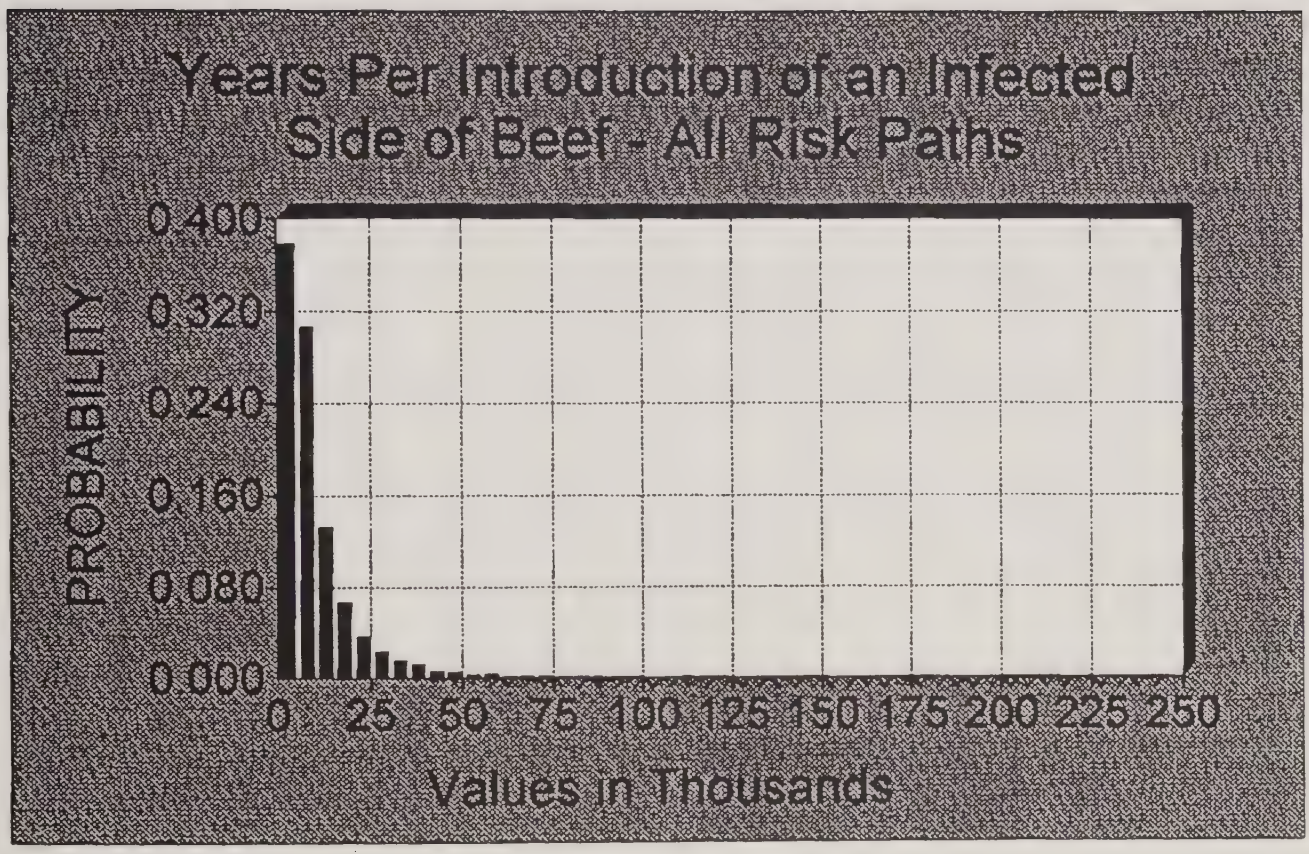
Prepared by Craig Chiolno 6/11/97 - 9:02 AM

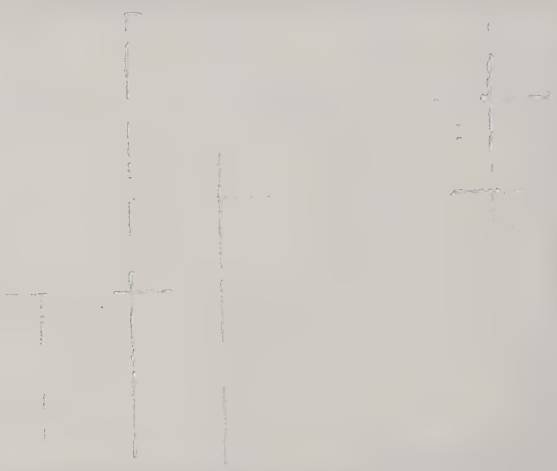
INTRODUCTION OF FMD FROM IMPORTATION OF BEEF FROM ARGENTINA
VALUE OF INPUT VARIABLES

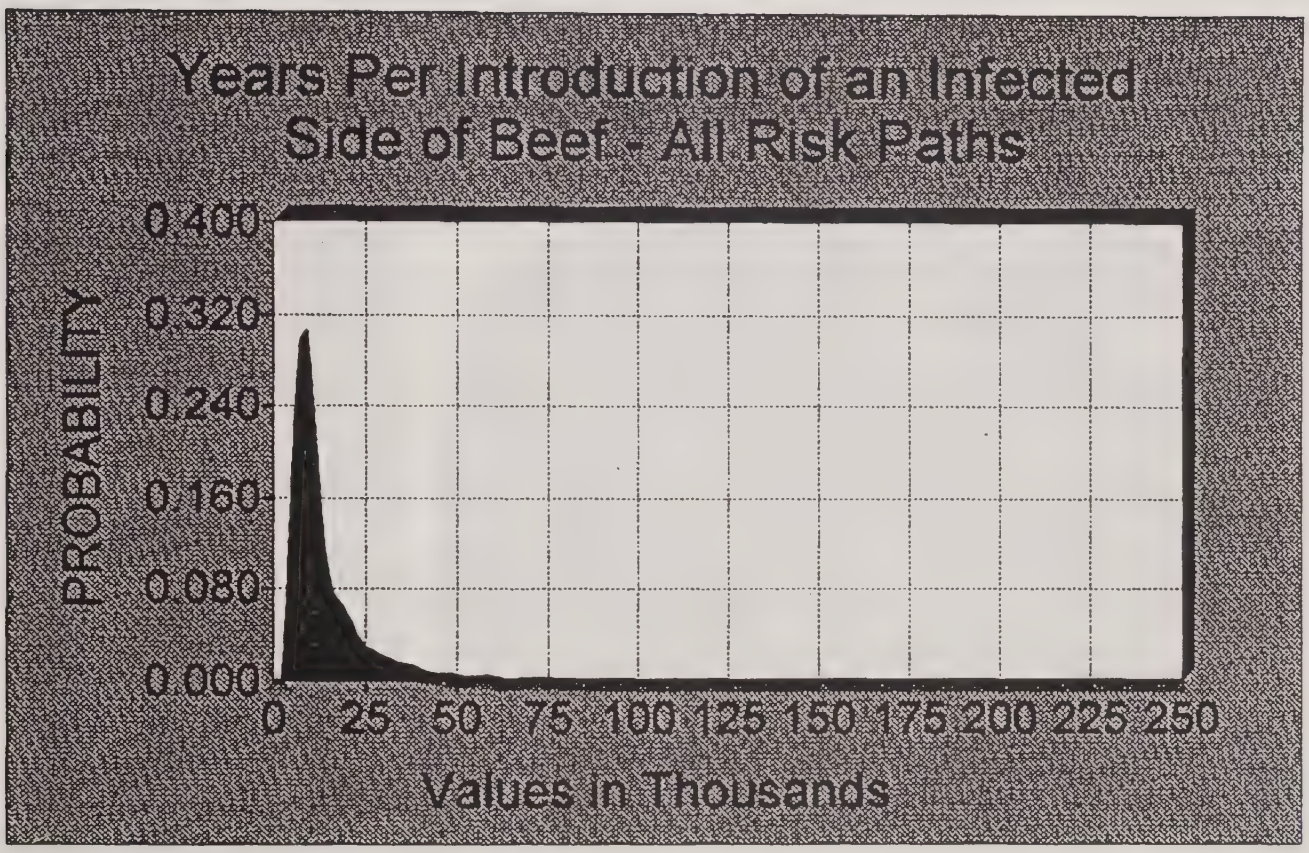
Estimates Of Input Variables		Minimum	MostLikely	Maximum
f1	Animal has FMD given compliance with 94.21 (e)	5.00E-09	5.00E-08	1.00E-07
f2	Meat complies with 94.21 (ε)	1	1	1
f3	FMD infection detected by ante-mortem exam	0.5	0.7	0.9
f4	FMD infection detected by post-mortem exam	0.05	0.1	0.2
f5	Meat complies with 94.21 (i)	0.98	0.99	0.999
f6	Meat has FMD virus	1	1	1
f7	Meat complies with 94.21(h) - matured to pH 5.8	0.8	0.9	0.99
f8	Diverted to domestic use	0.95	0.99	0.999
f9	Meat has FMD virus	0.05	0.1	0.15
f10	Meat complies with 94.21(h) - matured to pH 5.8	0.8	0.9	0.99
f11	Diverted to domestic use	0.95	0.99	0.999
f12	Virus killed	0.05	0.1	0.2

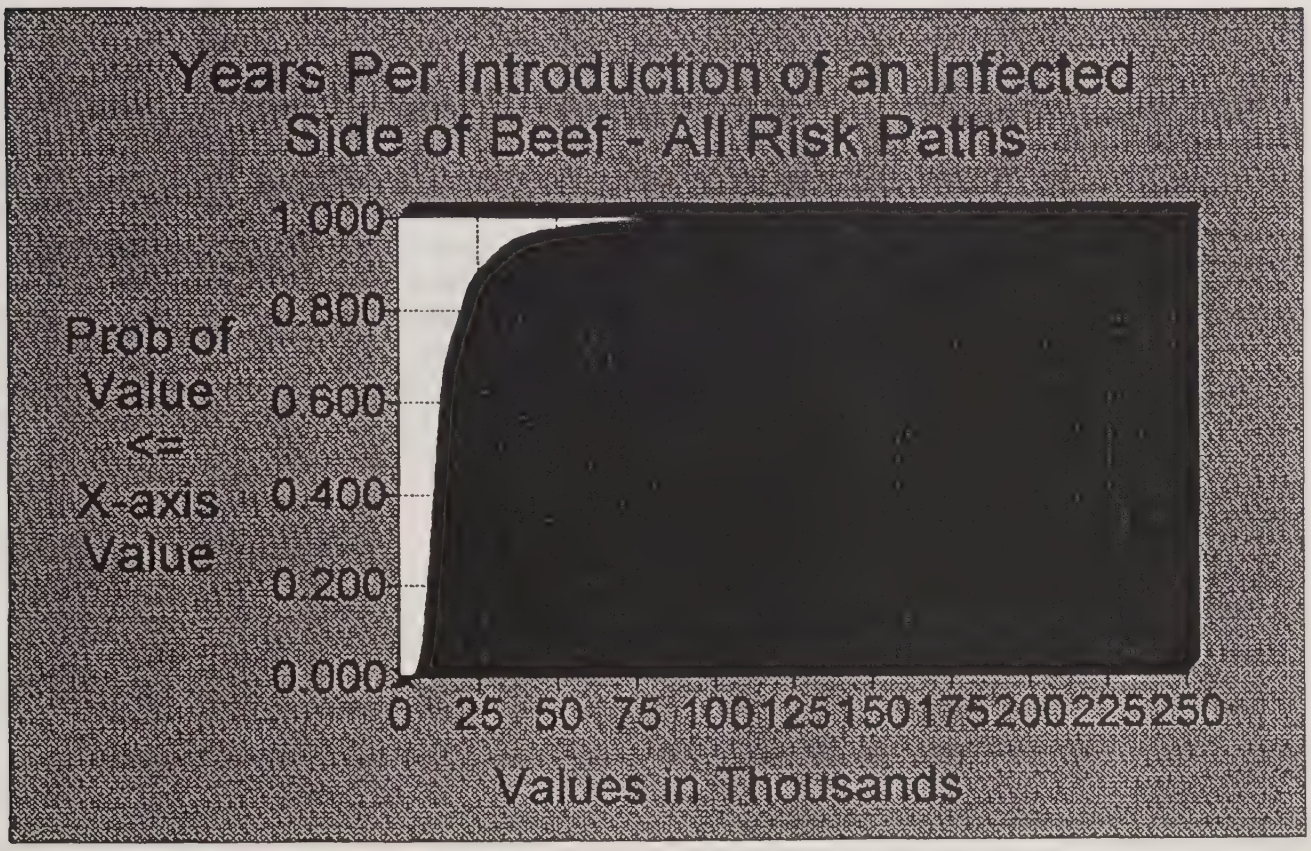
	A	B	C	D	E	F	G	H	I	J	K	L	M
1	INTRODUCTION OF FMD FROM IMPORTATION OF BEEF FROM ARGENTINA												
2		CORRESPONDS TO SCENARIO TREE											
3													
4	Estimates Of Input Variables												
5													
6		Total volume of slaughtered meat year in metric tons						20000					
7													
8		Maximum - Kg of slaughtered meat per animal						100					
9													
10		Most likely - Kg of slaughtered meat per animal						50					
11													
12		Minimum - Kg of slaughtered meat per animal						10					
13													
14		Minimum - number of animals slaughtered per year							200000	=H6*1000/H8			
15													
16		Most likely - number of animals slaughtered per year							400000	=H6*1000/H10			
17													
18		Maximum - number of animals slaughtered per year							2000000	=H6*1000/H12			
19													
20	c1	Number of sides per animal						2					
21													
22	v1	Number of animals slaughtered per year						866666.7	=RiskTriang(I14,I16,I18)				
23													
24	f1	Animal has FMD given compliance with 94.21 (e)						5.17E-08	=RiskTriang(0.000000005,0.00000005,0.0000001)				
25													
26	f2	Meat complies with 94.21 (c)						1					
27													
28	f3	FMD infection detected by ante-mortem exam						0.7	=RiskTriang(0.5,0.7,0.9)				
29													
30	f4	FMD infection detected by post-mortem exam						0.116667	=RiskTriang(0.05,0.1,0.2)				
31													
32	f5	Meat complies with 94.21 (i)						0.989667	=RiskTriang(0.98,0.99,.999)				
33													
34	f6	Meat has FMD virus						1					
35													
36	f7	Meat complies with 94.21(h) - matured to pH 5.8						0.896667	=RiskTriang(0.8,0.9,.99)				
37													
38	f8	Diverted to domestic use						0.979667	=RiskTriang(0.95,0.99,.999)				
39													
40	f9	Meat has FMD virus						0.1	=RiskTriang(0.05,0.1,.15)				

	A	B	C	D	E	F	G	H	I	J	K	L	M
41													
42	f10	Meat complies with 94.21(h) - matured to pH 5.8						0.896667	=RiskTriang(0.8,0.9,.99)				
43													
44	f11	Diverted to domestic use						0.979667	=RiskTriang(0.95,0.99,.999)				
45													
46	f12	Virus killed						0.116667	=RiskTriang(0.05,0.1,.2)				
47													
48													
49	**Estimates Of Output Variables**												
50													
51	x1 = c1 * v1 * f1 * (1-f3) * (1-f4) * f5 * f9 * (1-f10) * (1-f11)								4.93E-06	=H$20*H$22*H$24*(1-H$28)*(1-H$30)*			
52										H$32*H$40*(1-H$42)*(1-H$44)			
53	x2 = c1 * v1 * f1 * (1-f3) * (1-f4) * (1-f5) * f6 * f7 * (1-f12)								0.000194	=H$20*H$22*H$24*(1-H$28)*(1-H$30)*			
54										(1-H$32)*H$34*H$36*(1-H$46)			
55	x3 = c1 * v1 * f1 * (1-f3) * (1-f4) * (1-f5) * f6 * (1-f7) * (1-f8)								5.15E-07	=H$20*H$22*H$24*(1-H$28)*(1-H$30)*			
56										(1-H$(32)*H$34*(1-H$36)*(1-H$38)			
57													
58	**Summation Of Risk Output Variables**												
59													
60	Risk paths (x1 + x2 + x3) Infected sides of beef per year								0.0002	=I51+I53+I55			
61													
62	Years per introduction of infected side of beef - all risk paths								5007.805	=1/I60			
63													
64	Years per introduction of infected side of beef - x1								202639.3	=1/I51			
65													
66	Years per introduction of infected side of beef - x2								5148.32	=1/I53			
67													
68	Years per introduction of infected side of beef - x3								1940781	=1/I55			


Years Per Introduction of an Infected Side of Beef - All Risk Paths
PROBABILITY
0.400
0.320
0.240
0.160
0.080
0.000
0
25
50
75
100
125
150
175
200
225
250
Values in Thousands




Years Per Introduction of an Infected Side of Beef - All Risk Paths
PROBABILITY
0.400
0.320
0.240
0.160
0.080
0.000
0
25
50
75
100
125
150
175
200
225
250
Values in Thousands


Years Per Introduction of an Infected Side of Beef - All Risk Paths
Prob of Value <= X-axis Value
1.000
0.800
0.600
0.400
0.200
0.000
0
25
50
75
100
125
150
175
200
225
250
Values in Thousands

Summary Statistics

Simulation Results for Fmdbef01.xls

Iterations= 5000
Simulations= 1
# Input Variables= 11
# Output Variables= 4
Sampling Type= Latin Hypercube
Runtime= 00:02:00
Run on 6/11/97 at 10:34:03 AM

Summary Statistics

Cell	Name	Minimum	Mean	Maximum
I62	Years per	665.4512	10352.37	212896.8
I64	Years per	16769.87	646683.8	2.49E+07
I66	Years per	674.3557	10811.19	218649.8
I68	Years per	160404.8	7458493	5.09E+08
H22	(Input) Nu	204327.5	866672.4	1989080
H24	(Input) Ani	5.65E-09	5.17E-08	9.93E-08
H28	(Input) FM	0.501287	0.699999	0.896904
H30	(Input) FM	5.05E-02	0.116667	0.198736
H32	(Input) Me	0.980104	0.989667	0.998933
H36	(Input) Me	0.801337	0.896666	0.989164
H38	(Input) Div	0.950576	0.979667	0.998754
H40	(Input) Me	0.050195	1.00E-01	0.149584
H42	(Input) Me	0.80092	0.896666	0.988987
H44	(Input) Div	0.950557	0.979667	0.99871
H46	(Input) Vir	0.050517	0.116667	0.198942

Detail Statistics

@RISK Si	Run on 6/	Simulation	Iterations=					
Name	Years per	Years per	Years per	Years per	Number of	Animal ha	FMD infec	FMD infec
Descriptio	Output	Output	Output	Output	Triang(I14	Triang(0.0	Triang(0.5	Triang(0.0
Cell	I62	I64	I66	I68	H22	H24	H28	H30
Minimum	665.4512	16769.87	674.3557	160404.8	204327.5	5.65E-09	0.501287	5.05E-02
Maximum	212896.8	2.49E+07	218649.8	5.09E+08	1989080	9.93E-08	0.896904	0.198736
Mean =	10352.37	646683.8	10811.19	7458493	866672.4	5.17E-08	0.699999	0.116667
Std Deviat	12402.29	1141935	13261.19	1.63E+07	402775.9	1.94E-08	8.17E-02	3.12E-02
Variance	1.54E+08	1.30E+12	1.76E+08	2.67E+14	1.62E+11	3.76E-16	6.67E-03	9.72E-04
Skewness	4.710008	7.187502	4.852903	11.23831	0.539716	5.13E-02	-1.20E-04	0.305389
Kurtosis =	41.83173	89.57435	44.03848	234.163	2.400235	2.399979	2.40012	2.399716
Errors Cal	0	0	0	0	0	0	0	0
Mode =	3378.417	295314.1	3461.817	1097279	412560.4	4.96E-08	0.701003	0.100124
5% Perc =	1918.286	62518.32	1958.907	577030.5	334060.3	1.96E-08	0.563149	6.93E-02
10% Perc	2434.843	88229.22	2508.731	817467.4	389575	2.57E-08	0.589418	7.74E-02
15% Perc	2899.458	111264.1	2984.626	1079087	435284.3	3.03E-08	0.609487	8.35E-02
20% Perc	3341.988	134789.5	3425.812	1278595	482032	3.42E-08	0.626475	0.088713
25% Perc	3778.821	159234.5	3886.574	1516784	530158.6	3.77E-08	0.641409	9.33E-02
30% Perc	4220.951	184800.1	4331.377	1795013	579966.6	4.08E-08	0.654893	0.097432
35% Perc	4694.538	213415.1	4819.896	2098058	631597.4	4.37E-08	0.667305	0.101244
40% Perc	5226.397	243941.6	5387.735	2422295	685430.8	4.63E-08	0.678848	0.105125
45% Perc	5773.078	280940.4	5947.401	2762480	741209.8	4.89E-08	0.689735	0.109159
50% Perc	6448.291	323541.7	6626.011	3178136	799937.3	5.13E-08	0.69999	0.113383
55% Perc	7220.545	367819.9	7416.506	3687532	861353.2	5.38E-08	0.710258	0.117839
60% Perc	8102.261	419286.3	8333.746	4287672	926422.1	5.64E-08	0.721108	0.12253
65% Perc	9077.185	485215.5	9407.365	5053757	995772.8	5.92E-08	0.73265	0.127539
70% Perc	10421.77	562790.3	10750.14	6002518	1070187	6.22E-08	0.745047	0.132906
75% Perc	12195.93	683390.8	12681.75	7340792	1151284	6.55E-08	0.758537	0.13874
80% Perc	14232.01	809279.1	14788.64	8967485	1240729	6.92E-08	0.773447	0.145221
85% Perc	17016.01	1030076	17696.28	1.15E+07	1342584	7.33E-08	0.790418	0.152553
90% Perc	22019.27	1404106	23038.31	1.63E+07	1463003	7.82E-08	0.810478	0.161248
95% Perc	31397.52	2186096	32862.75	2.60E+07	1620238	8.46E-08	0.836669	0.172562
Filter Minimum =								
Filter Maximum =								
Type (1 or 2) =								
# Values F	0	0	0	0	0	0	0	0
Scenario #	>75%	>75%	>75%	>75%				
Scenario #	<25%	<25%	<25%	<25%				
Scenario #	>90%	>90%	>90%	>90%				

Detail Statistics

Meat com Triang(0.9 H32	Meat com Triang(0.8 H36	Diverted t Triang(0.9 H38	Meat has Triang(0.0 H40	Meat com Triang(0.8 H42	Diverted t Triang(0.9 H44	Virus killed Triang(0.05,0.1,0.2) H46
0.980104	0.801337	0.950576	0.050185	0.80092	0.950557	0.050517
0.998933	0.989164	0.998754	0.149584	0.988987	0.99871	0.198942
0.989667	0.896666	0.979667	1.00E-01	0.896666	0.979667	0.116667
3.88E-03	3.88E-02	1.06E-02	2.04E-02	3.88E-02	1.06E-02	0.031181
1.51E-05	1.51E-03	1.13E-04	4.17E-04	1.51E-03	1.13E-04	9.72E-04
-5.14E-02	-5.15E-02	-0.49087	-1.19E-04	-5.16E-02	-0.49087	0.305486
2.400115	2.400071	2.399967	2.400219	2.400057	2.399965	2.400109
0	0	0	0	0	0	0
0.989986	0.899866	0.989474	0.100251	0.899865	0.989722	0.100126
0.98308	0.830781	0.959897	6.58E-02	0.83079	0.959881	0.069348
0.984359	0.843554	0.963999	7.23E-02	0.843554	0.963989	7.74E-02
0.985336	0.853364	0.967144	7.74E-02	0.853377	0.967144	8.35E-02
0.986163	0.861625	0.969793	8.16E-02	0.861631	0.969798	8.87E-02
0.98689	0.868905	0.972132	8.54E-02	0.868899	0.972131	9.33E-02
0.987549	0.875481	0.974247	0.088721	0.875473	0.974247	9.74E-02
0.988153	0.881525	0.976191	9.18E-02	0.881529	0.976185	0.101245
0.988717	0.887174	0.977999	0.094715	0.887164	0.977994	0.105122
0.989245	0.892459	0.979693	9.74E-02	0.892462	0.979694	0.109167
0.989745	0.89746	0.981304	1.00E-01	0.897449	0.981304	0.113389
0.990227	0.902266	0.982831	0.102558	0.902263	0.982832	0.117839
0.990728	0.907287	0.98429	0.105278	0.907287	0.984288	0.122536
0.991262	0.91262	0.985691	0.108162	0.912636	0.985691	0.127532
0.991836	0.918369	0.98704	0.11126	0.918366	0.98704	0.132909
0.992459	0.924596	0.988337	0.114636	0.924595	0.988339	0.13876
0.993149	0.931507	0.989594	0.118373	0.931499	0.989596	0.1452
0.993935	0.939353	0.990862	0.122604	0.939328	0.990862	0.152552
0.994863	0.948622	0.992357	0.12762	0.948624	0.992356	0.161265
0.996074	0.960733	0.994298	0.134175	0.960754	0.994304	0.172564
0	0	0	0	0	0	0